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The Real Agitators

There is a type of man found in some power-plant organizations that has received too little publicity. The following is intended to show him up in his true light. If you are unfortunate enough to have to work in association with one of this character, show him this, or at least send it to him. It may wake him up.

NOT the least important factor in maintaining an efficient power-plant force is the inculcation of a spirit of good fellowship and harmony among the various members. This spirit must prevail not only among the men who do the actual work of operating and maintaining the plant, but also between the man or men in executive authority and those over whom this authority is exercised. The absence of this spirit of harmony is proof positive that there is something radically wrong, and it behooves the man who pays the bills to locate the trouble and eliminate it, no matter whose head is severed in the operation.

One of the greatest demolishers of this spirit of harmony in an organization is the obnoxious pest known as the tale bearer. He is one who plots against the reputation of his fellows with the sole idea of establishing himself in favor with the "boss." His eyes and ears are continually open to see and hear of the petty mistakes and shortcomings of those with whom he works. His business is to gather items concerning what is said and done around the plant and convey them to his chief. The faithful performance of this underhanded work is the highest ambition the tale bearer knows.

Of course, left to himself, he would be impotent. Therefore there is another type which deserves consideration, namely, the tale receiver. They go together—the man who carries the tale and the man who bends his ear to it. The official who encourages such despicable methods of obtaining information about his men is just as much to be censured as his henchman. In reality he is the worse offender of the two. An official who becomes a party to the business of tale-bearing is working with, at most, only the half-hearted support of his men. He probably is not aware of it. The fact that he was ever small enough mentally to become a party to any such combination is pretty good evidence that he is too small-minded to notice what harm results from his action. But it is there just the same.

We sometimes hear of men being discharged for being "agitators" among their fellow workmen. If the truth were known, the most effective disrupters of harmony in any power-plant organization are the tale bearers and receivers.

THEY ARE THE REAL AGITATORS! AWAY WITH THEM!

Contributed by A. T. Walker

Chain of Rocks Remodeled Boiler Plant—II

By H. F. GAUSS

Factors entering into the design of the new brick chimney serving the Chain of Rocks boiler plant. The cost of installing chain grates and coal- and ash-handling equipment is given, and an annual saving of over $8700 was effected.

FROM the previous article on the Chain of Rocks Remodeled Boiler Plant (*Power*, Aug. 14, 1917), it will be remembered that the installation consisted of six National boilers each rated at 365 hp. and two 250-hp. O'Brien water-tube boilers, all equipped with chain grates and superheaters. At the outset the stoker contractor regarded the old stack and breeching suitable for the remodeled plant, but there was some doubt in the minds of the Water Division engineers as to the advisability of retaining them. The stack was only 7 ft. diameter by 150 ft. high, the breeching areas were cramped, and it was intended to burn a cheap grade of bituminous screenings from Illinois mines. Definite information on burning this grade of coal on chain grates is lacking. From time to time charts and diagrams have appeared giving the draft required over the grate in hand-fired furnaces for burning various amounts of coal per square foot of grate area per hour, but similar data for stoker-fired boilers are not so plentiful. Gebhardt in his book "Steam Power Plant Engineering," gives a curve presenting this information for burning bituminous slack. The values given, however, appear high for screenings, and doubtless the fuel is intended to contain practically no coarse coal, being all "duff," or coal that will pass through ½-in. perforations. In *Power* of June 9, 1914, p. 808, Monnett gives a curve recommending the proper draft for the smokeless burning of bituminous mine run on hand-fired grates for different rates of combustion. The draft required in hand-fired furnaces is less than that required for chain grates, for the reason that the fuel bed can be kept open by resorting to slicing and cleaning and any holes that develop can be covered by skillful firing. With the chain grate slicing and poking should not be resorted to because of the impossibility of covering a broken fuel bed, and holes in the fire are disastrous to economy.

It would seem, after some consideration, that a mean between the drafts recommended by Monnett for hand-fired grates burning bituminous mine run and those recommended by Gebhardt for stokers burning slack would be safe values to use. Fig. 2 shows the two curves referred to and a mean curve drawn between them. Adding the superheaters to the National boilers increased the rating from 365 to 388 hp. The original intention was not to operate the boilers above normal rating, but it was decided that in the event of a new stack it should be of a height to produce draft intensity at least sufficient to operate at 150 per cent. of rating should occasion demand. The stoker specifications required that when operating at normal rating, an over-all efficiency of 68 per cent. be maintained, and included a bonus and forfeiture clause. When the installation was finished and tests were conducted, the guaranteed efficiency was not met. All indications pointed to lack of sufficient draft for proper and economical combustion. Sometimes a carload of coal was received that was burned successfully; on the other hand, when screenings were poor and contained an excessive amount of "duff," it became impossible to carry a uniform fire and to completely burn out the fuel.

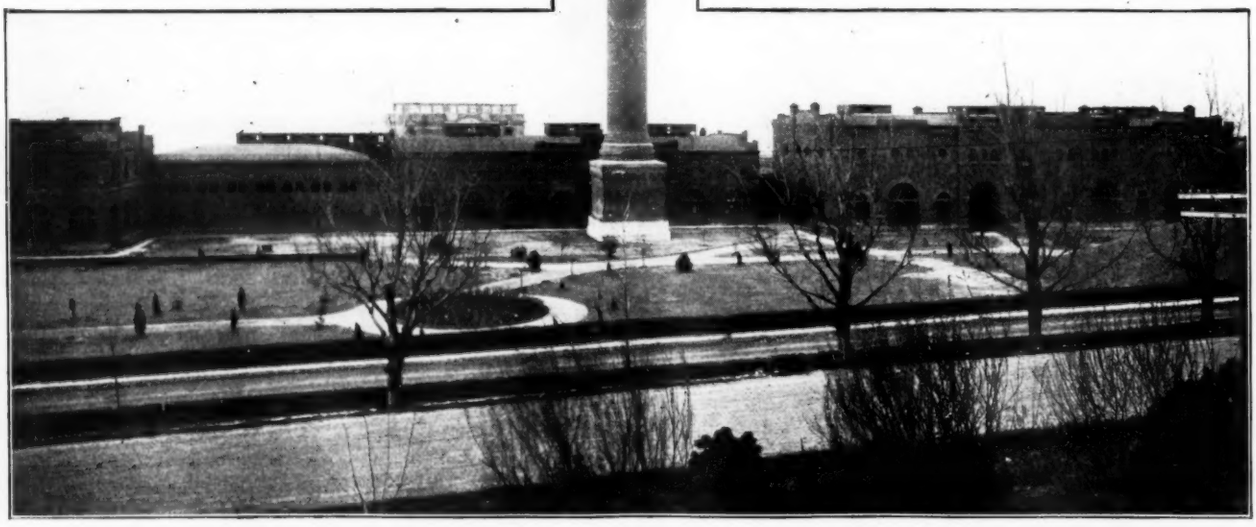


FIG. 1. CHAIN OF ROCKS PUMPING STATION—NEW STACK IN FOREGROUND

To remedy this condition and provide for future growth of the station, it was decided to build a stack

sufficiently large to accommodate six of the National boilers at normal rating or four at 150 per cent. of rating, which would mean 582 hp. per boiler, or a total of 2328 horsepower.

For convenience in reference, the following formulas are given:

$$HP. = \frac{G \times R \times H \times E}{34.5 \times 970.4} \quad (1)$$

$$R = \frac{HP. \times 34.5 \times 970.4}{G \times H \times E} \quad (2)$$

$$G = \frac{Heating\ Surface}{Constant} \quad (3)$$

in which

$HP.$ = Total boiler horsepower the stack is to serve at any one time.
G = Connected grate area of boilers;
R = Coal burned per square foot of grate per hour.
E = Over-all efficiency (furnace and boiler) = total heat in steam leaving superheater—heat in feed ÷ total heat in the coal as fired;
H = B.t.u. per pound of coal;
970.4 = Laten heat of steam at 212 deg. F.

The constant in formula (3) varies from 45 to 60, a generally accepted value being 50.

In most problems of design the horsepower, efficiency, B.t.u. value and the grate surface are given. For the case in hand, then, $HP.$ = 582 per boiler or a total of 2328, E = 68 per cent., H = 10,000 B.t.u. and G = 80 sq.ft. per boiler. Hence equation (1)

$$R = \frac{582 \times 34.5 \times 970.4}{80 \times 10{,}000 \times 0.68}$$

$$= 35.8\ lb.\ of\ coal\ per\ sq.ft.\ per\ hour$$

Referring to the mean curve in Fig. 2, it will be found that to burn 35.8 lb. of screenings per square foot of grate area per hour requires a draft over the fire of 0.5 inch.

Data on the draft losses through various settings presented in *Power* of June 2, 1914, p. 769, indicate that the draft over the fire in the National boilers, which have liberal tube spacing, should be about 50 per cent. of that on the stack side of the damper. With 0.5 in. draft over the fire the draft at the stack side of the damper would be 1 in. Generally accepted values for the losses through the breeching and stack connections are 0.1 in. per 100 ft. of straight breeching, 0.05 in. for each right-angled turn and 0.05 in. for each entrance from a boiler.

Fig. 3 is a plan and elevation showing a layout of the new breeching. The distance from the stack to the farthest boiler is 110 ft.; there are one right-angled bend and three entrances between this boiler and the stack. The total breeching loss, then, is 0.11 + 0.05 + 0.15 = 0.31 in. The draft at the stack entrance must be

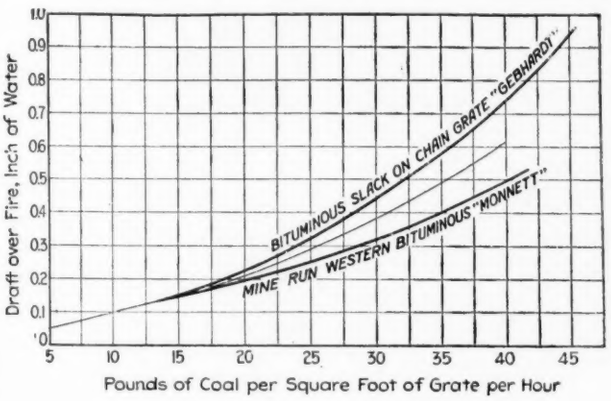


FIG. 2. DRAFT OVER FIRE

the sum of the losses through the grate and fuel bed, the setting and damper, and the breeching and stack connections; viz., 0.5 in. through the grate and fuel bed plus 0.5 in. through the setting and damper plus 0.31 in. through the breeching, or a total of 1.31 in. must be the draft at the entrance to the stack. Given the draft intensity required, a well-known formula for determining the height of a stack is

$$H = D \div K,$$

where

H = Height above the grates in feet;

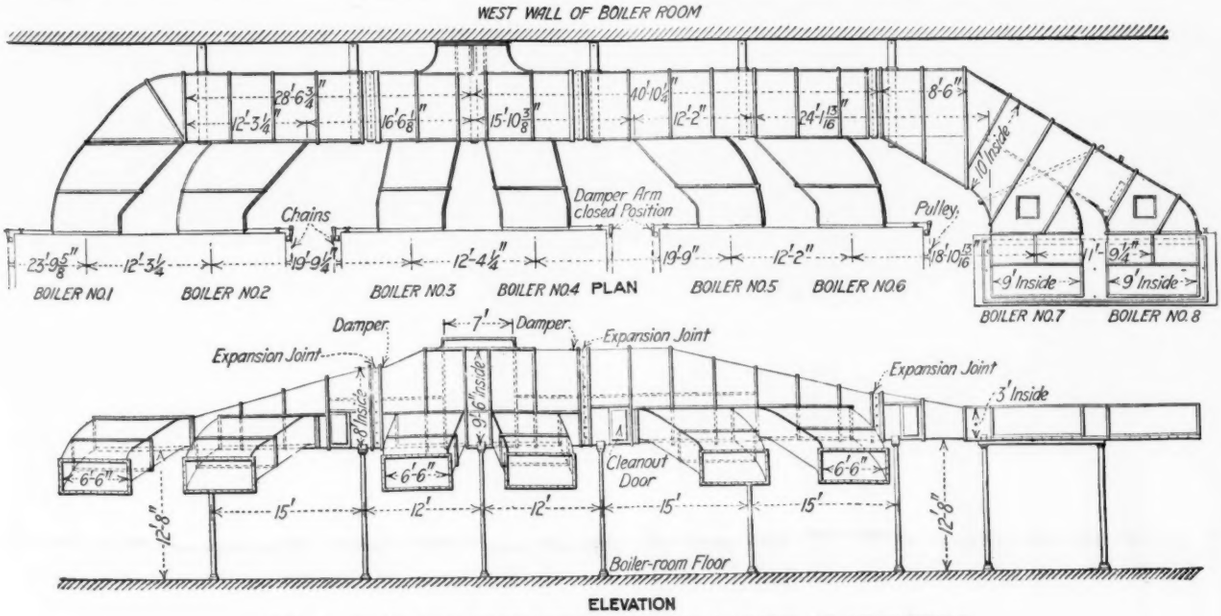


FIG. 3. PLAN AND ELEVATION SHOWING LAYOUT OF BREECHING

D = Draft in inches of water; K = Constant having the following values for various temperatures:

Temp. Stack Gases	K	Temp. Stack Gases	K
750	0.0084	500	0.0067
700	0.0081	450	0.0063
650	0.0078	400	0.0058
600	0.0075	350	0.0053
550	0.0071		

With the temperature of the stack gases 500 deg., the height of the stack required is 1.31 ÷ 0.0067 = 196 feet.

To compensate for the skin friction in the stack itself, use may be made of the following formula given in "Steam":

$$d = \frac{F W^2 C H}{A^3}$$

d = Draft loss in inches of water;
W = Weight of gas in pounds passing per second;
C = Perimeter of stack in feet;
H = Height of stack in feet;
A = Cross-sectional area in square feet;
F = Constant having the following values:

F	Condition
0.0015	Steel stacks at 600 deg. F.
0.0011	Steel stacks at 350 deg. F.
0.0020	Brick stacks at 600 deg. F.
0.0015	Brick stacks at 350 deg. F.

By interpolation, F = 0.0018 for a brick stack with the gases at 500 deg.

For perfect combustion, with bituminous coal having 10,000 B.t.u. per lb. and a hydrogen content of 3 per cent. of the combustible, the maximum theoretical CO_2 obtainable is 19.5 per cent. and the theoretical air required per pound of coal is 7.6 lb. Assuming that as low as 7 per cent. CO_2 may be obtained, the actual air required becomes $\frac{19.5}{7} \times 7.6 = 21.17$ lb. per pound of coal. The pounds of coal required per boiler horsepower per hour is 5, the air per hour is 5 × 21.17 = 106 lb., and the weight of flue gases per hour is 111 lb. The total gas per second is

$$W = \frac{2328 \times 111}{3600} = 71.8 \text{ pounds}$$

As will be shown later C = 228.27 ft., H = 196 ft., A = 63.62 sq.ft. Then

$$d = \frac{0.0018 \times 71.82 \times 28.27 \times 196}{63.62^3} = 0.1996$$

To produce sufficient draft, then, to overcome this frictional resistance will require an additional height of H = 0.1996 ÷ 0.0067 = 29 ft. The total height then becomes 196 + 29 = 225 feet.

With a connected grate area of 320 sq.ft. under four National boilers and a rate of combustion of 35.8 lb. of coal per square foot per hour, the total coal burned per hour is 11,456 lb. The weight of air required for combustion per hour is 21.17 × 11,456 = 242,523 lb. Adding the weight of the coal, 11,456 lb., to this quantity gives 253,979 lb. flue gases per hour, or 70.55 lb. per second. The following table giving the specific volume of flue gases at various temperatures is convenient for determining the volume of flue gases per second passing up the stack:

Temperature	Lb. per Cu.Ft.	Temperature	Lb. per Cu.Ft.
400	0.046223	525	0.040364
425	0.044920	550	0.039365
450	0.043686	575	0.038415
475	0.042520	600	0.037510
500	0.041410		

If V is the volume of flue gas passing up the stack per second, S the specific volume and W the weight in pounds per second, then $V = W \div S$. For a temperature of 500 deg., S = 0.04141 and V = 70.55 ÷ 0.04141 = 1704 cu.ft. per sec. It has been stated that a velocity of 30 ft. per sec. should not be exceeded. Using a velocity of 26 ft., the area of the stack would be 1704 ÷ 26 = 65.5 sq.ft. The corresponding diameter is practically 9 ft. It was decided to make the diameter of the stack 9 ft. 6 in. at the point where the breeching enters and 8 ft. 8 in. at the top. If the mean diameter of the stack is considered as 9 ft., the area becomes 63.6 sq.ft. and the ratio of stack to grate area becomes 63.6 to 320, or practically 1 to 5.

Fig. 4 is a sectional elevation of the stack, giving the details of construction and the various dimensions. The total height above the base was made 225 ft., as indicated. With the exception of the base, which was masonry and concrete, the entire stack was laid up with standard square brick, no radial brick being used. The inside firebrick lining, which extends up a distance of 80 ft., was laid up in mortar composed of three parts cement, five parts fireclay and two parts river sand.

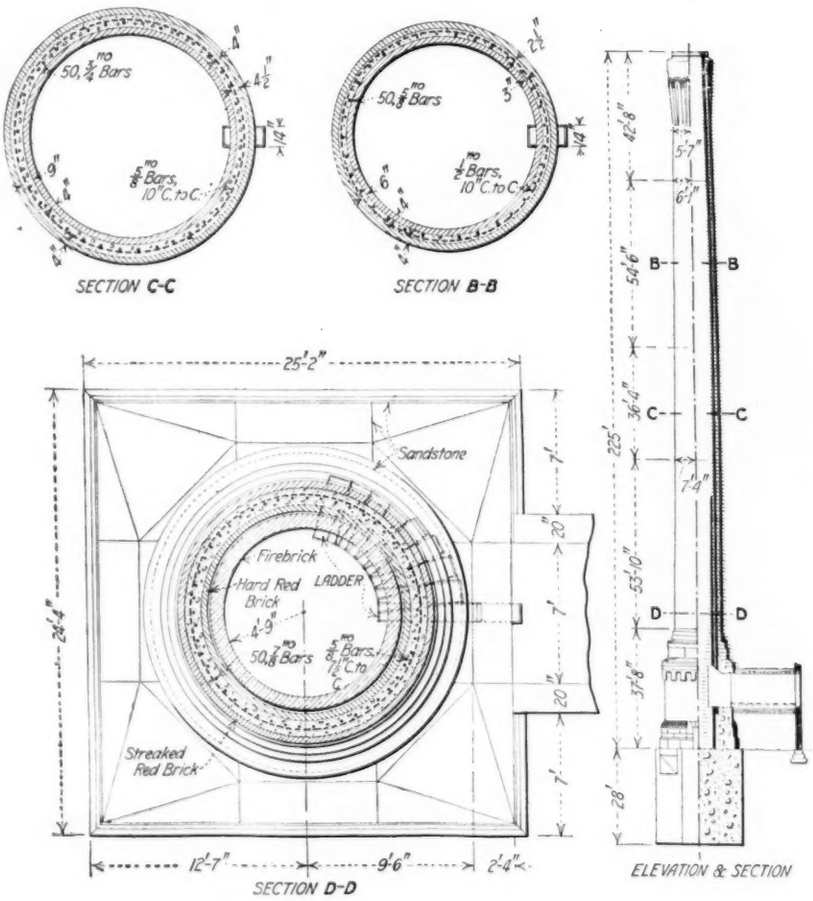


FIG. 4. CHIMNEY DESIGN AND DIMENSIONS

The remainder of the brickwork was laid up with 2½ parts of sand and one part of cement with 10 lb. of lime to every 100-lb. sack of cement.

The new stack was built on the old foundation, which had been sunk originally to bedrock some 35 ft. below the surface of the ground. Although it was necessary to broaden the top of the old foundation to accommodate the new stack, its use effected a considerable saving. It was of course imperative that the plant be kept in operation during reconstruction, and for this reason a temporary steel stack of 6 ft. diameter and 175 ft. high was erected for use while the new stack was being built.

TABLE I. OPERATING COST BEFORE PLANT WAS REMODELED
YEAR ENDED MAR. 31, 1914

Total coal burned, tons	18,170
Egg coal unloaded, $1.65 per ton	$29,980
14 firemen at $90 per month	15,120
14 coal passers at $65 per month	10,920
1 foreman at $100 per month	1,200
1 boiler washer at $75 per month	900
Total	$58,120
Total water evaporated, pounds	218,040,000
Coal and labor cost per 1,000 pounds of steam	26.6 c.

At the stack the breeching was made 10 ft. 6 in. high by 7 ft. wide, giving an area of 73.5 sq.ft., which is 15 per cent. greater than that of the stack and bears a ratio to the grate surface of 1 to 4.35. The arrangement and dimensions of the new breeching are shown in Fig. 3, and Fig. 5 is a reproduction of a photograph of the breeching taken from the top of the boilers.

While the new stack was being built, it was necessary to burn a good grade of crushed egg coal on the stokers to carry the load, but with the new stack in service screenings are burned without trouble.

In a future issue of *Power* the various schemes of baffling tried and the one finally successful in reducing the flue temperature to the 500 deg. on which the draft calculations were based, will be given, and also a discussion of some of the difficulties met in securing the desired superheat.

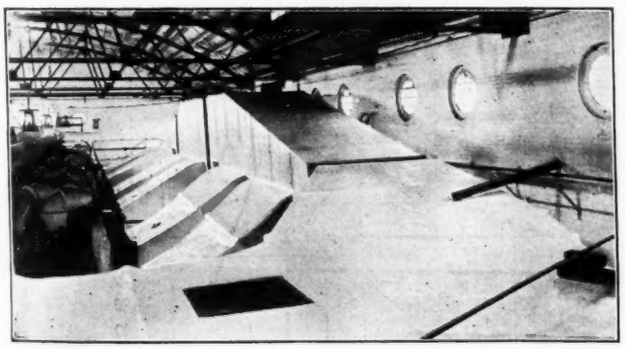


FIG. 5. NEW BREECHING FROM BOILER TOPS

A fairly accurate idea of the saving effected by making the changes described, can be had from the accompanying tables.

Recent tests on the new installation indicate that an efficiency of 68 per cent. can be obtained easily, and the operating efficiency will be at least 65 per cent. including stand-by losses. Thus far it has not been possible to definitely establish these figures except by isolated tests, because the remodeling is not yet entirely completed and the daily logs cannot be taken as indicating the results possible. It is expected to secure an operating efficiency of 70 per cent. when the remodeling is finished, including stand-by losses.

Based on an efficiency of 65 per cent., the evaporation of water per pound of coal containing 10,000 B.t.u. is 5.9 lb. To evaporate 218,040,000 lb. of water would then require 36,956,000 lb., or 18,478 tons, of coal.

TABLE II. OPERATING COST AFTER PLANT WAS REMODELED
Based on Results of Tests

Total coal burned per year, tons	18,478
Screenings unloaded at $1.53	$28,271
6 firemen at $90 per month	6,480
8 coal passers at $65 per month	6,240
1 foreman at $100 per month	1,200
1 boiler washer at $75 per month	900
Total	$43,091

TABLE III. COST OF RECONSTRUCTION

Eight chain-grate stokers	$10,988
Coal and ash-handling equipment	26,770
Cost of superheaters	10,070
Cost of tunnel	12,000
Total	$59,828
Return to scrap, 5 per cent	2,391
Balance	$57,437
Interest, 6 per cent	$3,446
Annual depreciation (20 years)	2,872
Coal and labor	43,091
Total annual charge	$49,409
Annual saving	$8,711

Coal, labor and interest cost per 1,000 lb. steam, $0.227.
Time required to pay for investment is practically 7 years.

The cost of the new stack and breeching and also the remodeling of the boilers was not included in the computations for ascertaining the saving effected, for the reason that this part of the work was necessary in any event and could not justly have been charged against the labor-saving machinery.

The new stack, including the foundation and temporary steel stack, cost $12,310, or $5.29 per horsepower. The new breeching cost $3475, or $1.49 per horsepower. The old brick stack was torn down by hand at a cost of $1000. These figures mean nothing, on account of the abnormal condition of the markets at the present time, but they are interesting for purposes of comparison.

Central Station Uses Refuse Wood for Fuel

In the report of the "Committee on Progress" of the N. E. L. A. is given a short description of a contract of unusual nature and of mutual advantage, being successfully carried out by the Oregon Power Co. and the Booth-Kelly Lumber Co., of Springfield, Ore. The latter company operates a large sawmill and planing mill and, by means of conveyors and blower systems, transmits a portion of the refuse wood to the adjacent plant of the central-station company. The power company pays $0.005 per kw.-hr. at the switchboard to the lumber company for all energy generated, and the lumber company in turns pays $0.009 per kw.-hr. for the first 1,000,000 kw.-hr. used in each current year, and $0.008 per kw.-hr. for all over this amount. The contract further calls for a minimum usage on the part of each party to the agreement. For instance, the power company agrees to purchase sufficient fuel to generate a minimum of 3,000,000 kw.-hr. per annum in excess of the amount used by the lumber company, and the latter agrees to use a minimum of 1,500,000 kw.-hr. per annum to operate 76 motors in and about its mills.

The steam required by the dry kilns, heating the offices and operating devices about the sawmill, for

which electricity has not as yet taken the place of steam, is secured also from the Oregon Power Co. This steam is used in such quantities as to require an 8-in. pipe with boiler pressure of 150 lb. to supply it, and is purchased at a flat rate of $45 a month. This appears to be a very low rate until it is understood that no account is taken of the fuel to generate this steam. In other words, the lumber company pays $45 a month for the use of the boilers of the power company and furnishes the fuel.

The average energy consumption of the lumber mill is about 8500 kw.-hr. a day, and approximates daily 40 per cent. of the connected load, which was the load factor figured on when building the plant. In addition to this energy used by the Booth-Kelly company, the central station generates for commercial purposes from 250,000 to 500,000 kw.-hr. per month. In the accounting at the end of the month the power company pays the lumber company from $700 to $1200 after satisfying its account for energy used.

Practical Talks on Controllers—Controllers for Wound-Rotor Motors*

The characteristics of the squirrel-cage and wound-rotor types of induction motors are discussed, and then the operation of types of controllers for wound-rotor induction motors are explained.

THE standard squirrel-cage and wound-rotor types of induction motors have approximately the same speed-torque and speed-current characteristics after they are up to full speed, but these characteristics are somewhat different during starting. For these reasons the nature of the loads during starting should be carefully considered before the type of induction motor is selected. The speed-torque and speed-current curves for these two types of standard induction motors during their starting period are given in Figs. 1 and 2.

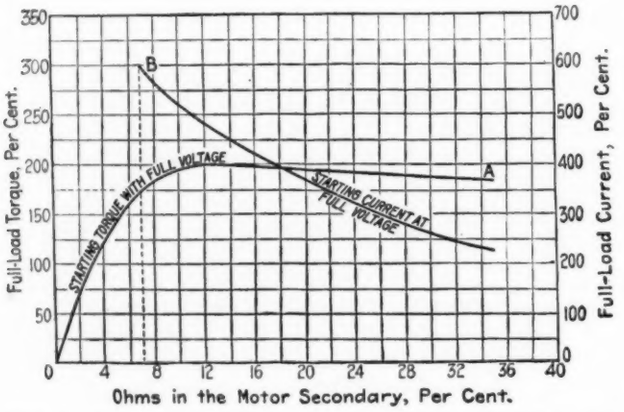


FIG. 1. CHARACTERISTIC CURVES FOR A WOUND-ROTOR INDUCTION MOTOR

Fig. 1 gives characteristic curves of a wound-rotor induction motor when at rest, which show the relations between current and torque plotted against secondary resistance, while Fig. 2 gives characteristic curves of a squirrel-cage induction motor when at rest, which shows the relations between current and torque plotted against applied voltage.

The method used for starting the wound-rotor types is to apply full rated voltage on the stator and by varying the resistance in the rotor circuit to obtain any required torque within the range of the motor. Referring to Fig. 1, curves *A* and *B*, it will be seen that with 35 per cent. normal resistance in the rotor circuit, the motor will be drawing 225 per cent. normal current and developing 180 per cent. normal torque. By reducing the resistance in the rotor circuit to 12 per cent. normal, the current will increase to 480 per cent., while the torque will increase to only 200 per cent. By still further decreasing the ohms in the rotor circuit to 6 per cent., the current will increase to 600 per cent., while the torque will diminish to 175 per cent., as indicated by the dotted lines, which is less than that developed with 225 per cent. current.

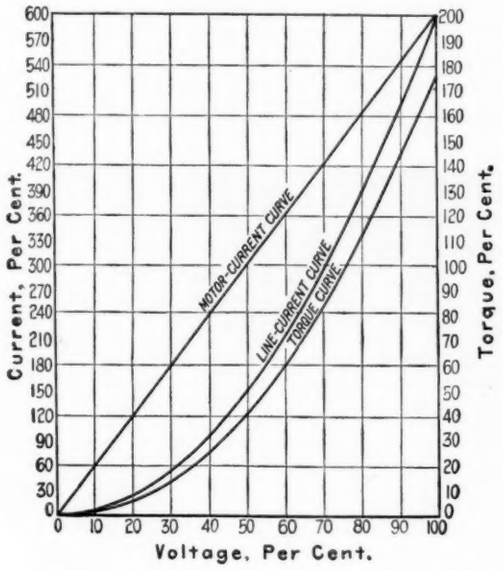


FIG. 2. CHARACTERISTIC CURVES FOR A SQUIRREL-CAGE INDUCTION MOTOR

Note: The ohms necessary in each phase of the secondary of a wound-rotor induction motor, to produce full-load torque with the rotor at standstill and full voltage applied to the primary, are termed 100 per cent. ohms. All percentages are based on this value.

A squirrel-cage induction motor has in the rotor a definite amount of resistance which cannot be varied. The only means of varying the torque and current during starting is to vary the impressed volts. Standard squirrel-cage motors develop 1.25 to 1.75 times their normal full-load torque when rated voltage is applied

*The material in this article was contributed by B. W. Jones, industrial control engineer, General Electric Co., Schenectady, N. Y.

at standstill. Under this starting condition the line currents will be about 5.5 to 7 times full-load running current, depending upon the frequency and secondary resistance of the motor. When less than line voltage is applied by means of a compensator, the torque and line currents will decrease as the square of the applied motor voltage, while the motor current will decrease as a direct function of the voltage. If a compensator or auto-transformer is used for reducing the voltage applied to the motor, then the relations between voltage, torques and currents are expressed thus:

$$\text{Line current} = (\text{inrush current at rated voltage})\left(\frac{\text{applied motor voltage}}{\text{rated motor voltage}}\right)^2$$

$$\text{Motor current} = (\text{inrush current at rated voltage})\left(\frac{\text{applied motor voltage}}{\text{rated motor voltage}}\right)$$

$$\text{Torque} = (\text{Torque at rated voltage})\left(\frac{\text{applied motor voltage}}{\text{rated motor voltage}}\right)^2$$

For example, if the full line voltage is 220, the inrush current when starting the motor on full line voltage, 100 amperes, and the torque at rated voltage equals 150 per cent. full-load torque, the rated motor voltage should be that of the line, or, in this case, 220. Then, when the motor is started on the 50 per cent. tap from a compensator, in this problem 100 volts, line current $= 100\left(\frac{110}{220}\right)^2 = 25$ amp.; motor current $= 100\left(\frac{110}{220}\right) = 50$ amp.; and torque $= 150\left(\frac{110}{220}\right)^2 = 37.5$ per cent. full-load torque.

These relations obtain because the stator flux varies directly with the impressed voltage, the rotor current which is produced by the stator flux varies directly with the latter, and the torque produced is a resultant.

Fig. 2 shows the curves for torque and current plotted against voltage of a squirrel-cage induction motor having the same characteristics as those shown for the wound-rotor motor in Fig. 1, when the primary volts are varied from 0 to 100 per cent. Thus, at 100 per cent. volts the torque produced is 175 per cent. and the current is 600 per cent.; whereas, at 50 per cent. voltage, the torque produced is 42 per cent., the motor current is 300 per cent. and the line current is 150 per cent. of normal.

If full-load torque is desired at standstill, 75 per cent. voltage must be applied, which will result in a motor current of 450 per cent. and a line current of 340 per cent. With the wound-rotor motor 100 per cent. full-load torque can be produced with 100 per cent. full-load current. It is therefore evident that a standard squirrel-cage induction motor is not suitable for starting heavy loads, because the current taken from the line is excessive in comparison with the current taken by the wound-rotor type when starting the same load.

Fig. 6 is a simple elementary sketch, and Fig. 3 is a photograph of a dial-type control equipment for a wound-rotor induction motor. If full line voltage is applied to the stator and 100 per cent. resistance is in the secondary, or rotor circuit, the motor will exert normal

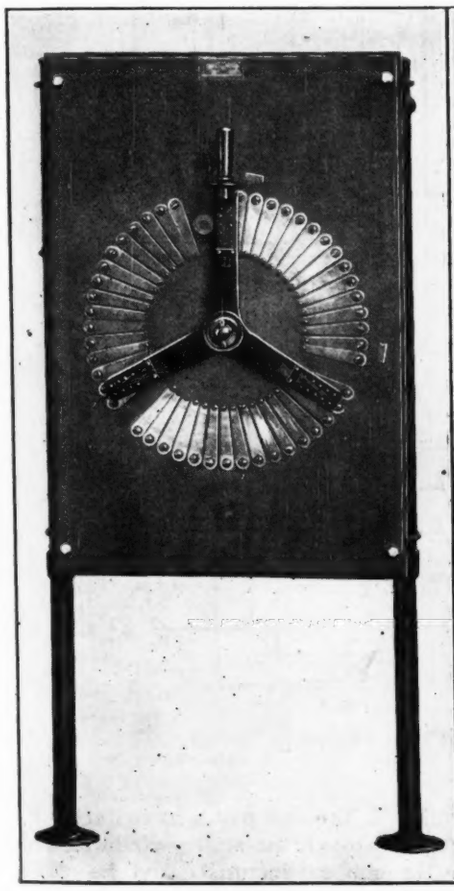


FIG. 3. DIAL-TYPE CONTROLLER FOR WOUND-ROTOR MOTOR

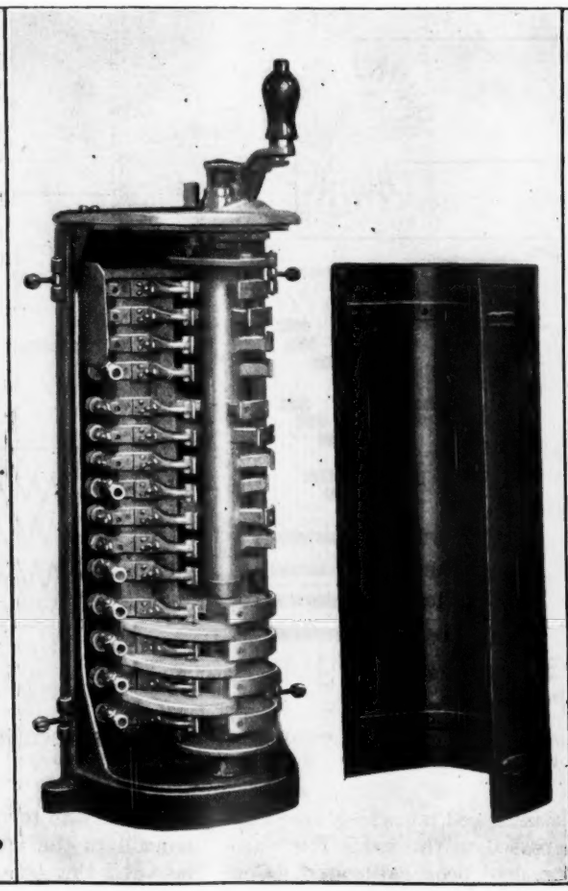


FIG. 4. DRUM-TYPE CONTROLLER FOR WOUND-ROTOR MOTOR

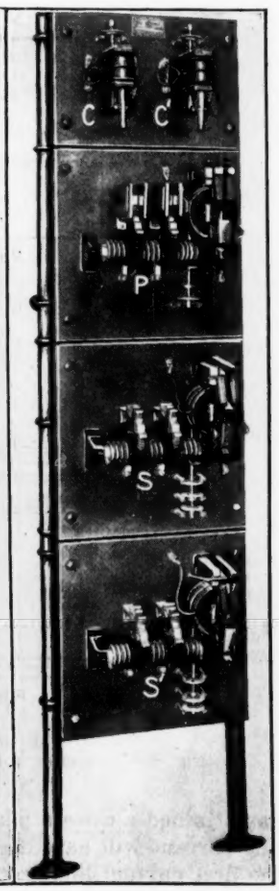


FIG. 5. AUTOMATIC A.-C. CONTROLLER

full-load starting torque. By turning the three mechanically connected arms in a clockwise direction, the resistance will be gradually decreased and the motor brought up to full speed when all the resistance is short-circuited. Fig. 4 is a photograph, and Fig. 7 is a connection diagram of a drum-type controller for accomplishing the same purpose.

The two foregoing equipments are manually operated and require the attention of an operator to start and stop them. Fig. 8 is a connection diagram, and Fig. 7 shows a contactor panel for a wound-rotor induction motor which accomplishes the same purpose as Figs. 3 and 4, but does not really need the attention of an operator. One double-pole contactor P is used for controlling the primary, and two double-pole contactors, S and S', are used to short-circuit the starting resistor in two steps. These latter contactors are controlled by two current-limit relays, C and C'. The first resistance contactor S cannot close until the motor has attained a certain partial speed, at which speed the line current will have decreased to the value for which the first current-limit relay had been calibrated. Contactor S on closing shorts a portion of the starting resistor and also makes a circuit through its bottom interlock disk for the second contactor S' to operate as soon as the second relay will permit; but as the tips of the first contactor touch before its bottom interlock bridges its two studs, the line current has already increased through the second current-limit relay, which prevents the second contactor from closing until the motor further accelerates. When the line current again decreases to the calibrating point of the second relay, the relay will function, allow the second contactor to close and short the entire starting resistor, bringing the motor to full speed. Starting and stopping are controlled by a master switch which can be a small knife switch, a float switch, pressure governor or any similar device.

Referring to Fig. 8, the operation of the panel in detail is as follows: Closing the master switch, Fig. 8, completes the circuit for current to flow from L_1 through coil X on contactor P and back to L_2, as indicated. This will close contactor P, which supplies full line voltage to the primary or stator winding of the motor, as in Fig. 9, and this in turn will induce a voltage in the secondary or rotor of the motor. An external resistor marked R_1-R_9; R_1-R_6; R_1-R_3, is connected in "Y" to the rotor slip rings; this will result in a current and torque proportional to the ohmic value of the resistance, as shown in Fig. 1. An average equipment would allow about 200 per cent. current to flow, which would produce a proportional torque.

Assuming an instantaneous polarity, as in Fig. 9, the current through the stator windings of the motor is from the line terminal L_1 through pole a of contactor P, down into the motor, through the stator windings and back to the line through conductor L_2 and L_3. The rotor circuit is from slip ring M_2 to R_7 through the bottom section of the resistance to R_1, where it divides and returns through the middle and top sections of resistance to R_3 and R_6, back to the slip rings M_3 and M_1 into the rotor winding, as indicated by the arrow head.

After the tips of the contactor P have touched and the current has been established, its interlock disk makes contact across studs 4-9. This makes a circuit from terminal 4 on coil X around and across 4-9, through coil Y of contactor S, across disk 10-11, up through the shunt coil J of relay C, back down to 5 on the interlock of contactor S, on down and through the interlock disk 5-12 on contactor S' up to the other

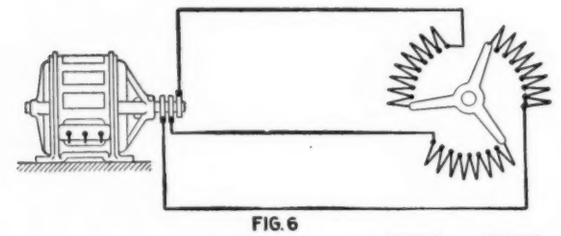


FIG. 7

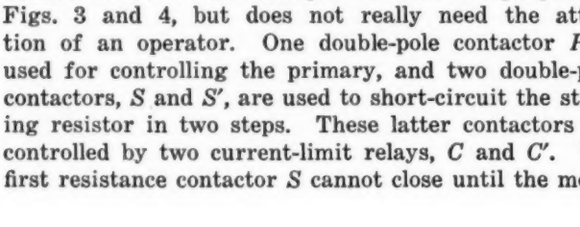


FIG. 6

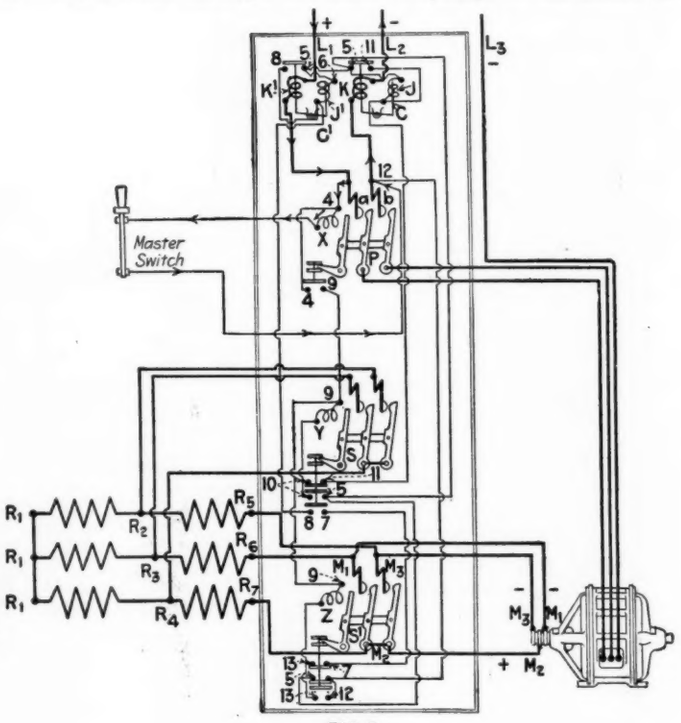
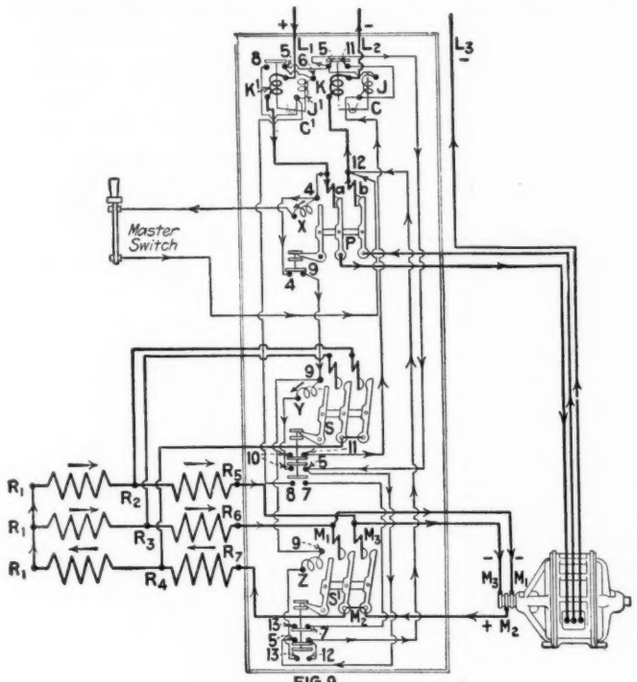
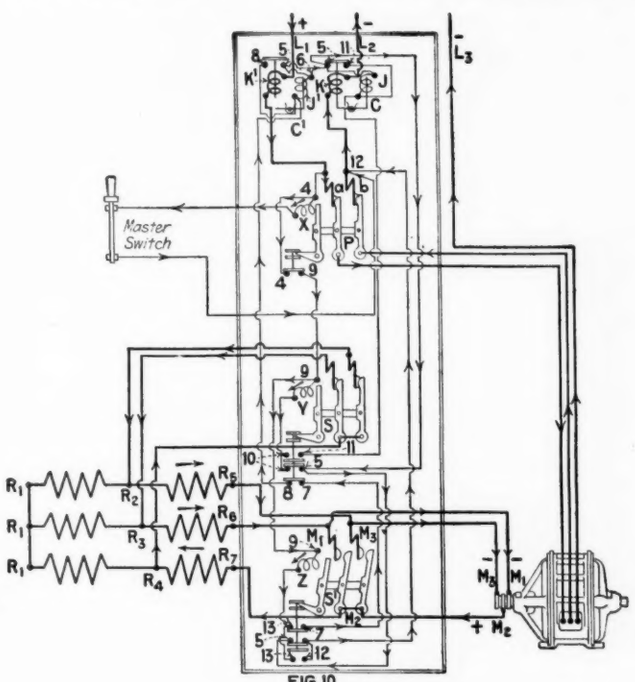


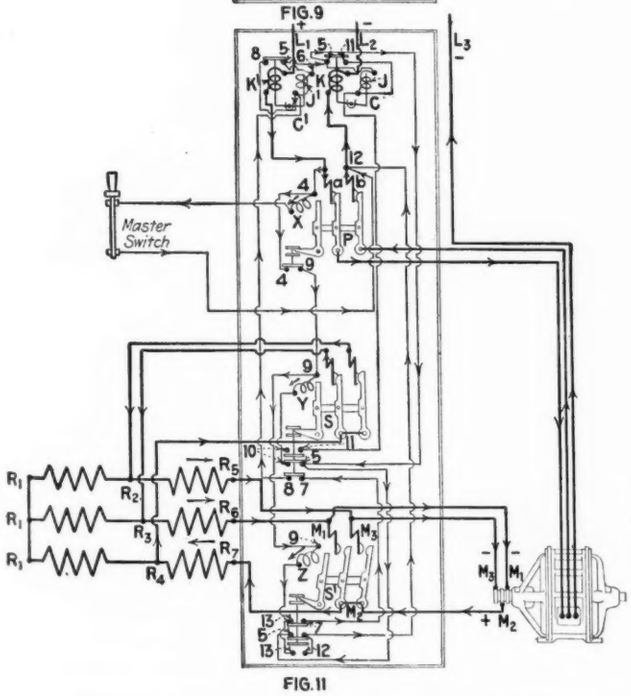
FIG. 8

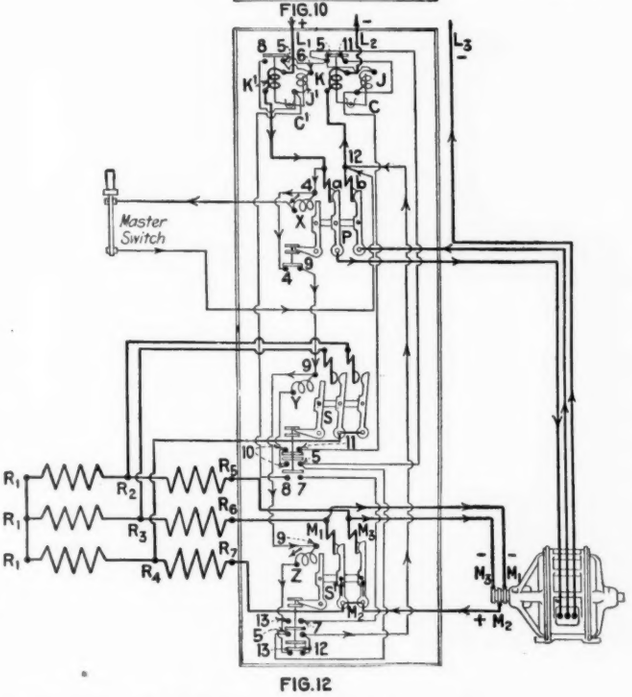
FIGS. 6 TO 8. WOUND-ROTOR INDUCTION MOTOR CONTROLLER CONNECTIONS
Fig. 6—Connection for dial-type controller. Fig. 7—Connections for drum-type controller. Fig. 8—Connections for automatic-type controller

side of the line L_2. Since relay coil J has a much higher reactance than coil Y on contactor S, most of the voltage will be across the relay shunt coil J which will raise its core or plunger as shown, but contactor S will not close until the plunger in the series coil K of the relay drops after the motor current, which is flowing through this cent. At this current value the plunger in the series coil will drop and short-circuit relay C contacts 5-11, which will put full-line voltage across the S contactor coil Y and close this switch, as shown in Fig. 10. This short-circuits sections of the resistor marked R_1-R_2; R_1-R_3; R_1-R_4, as indicated, and causes the current to









FIGS. 9 TO 12. AUTOMATIC-CONTROLLER CONNECTIONS FOR WOUND-ROTOR MOTOR

coil, decreases to the proper value. This plunger is usually adjusted to drop when the shunt core has been lifted and the full-load current of the motor, or less, is flowing through the series coil.

Since about 200 per cent. initial-inrush current was allowed, this plunger will not drop until the motor partly accelerates and the current decreases to 100 per again suddenly increase to 200 per cent. When contactor S closes, it forces its 3-disk interlock down so that 10-11 opens just after 10-5 closes, and 8-7 closes just after the main tip of the contactor touches. Closing the disk interlock 5-10 makes a holding circuit for coil Y through disk 10-5 down through 5-12 contacts on switch S', up to L_2, the negative side of the line.

Opening disk contacts 10-11 on switch S opens the shunt coil J on relay C, which allows this relay to drop back to normal position, as shown in Fig. 11. Closing the interlock 8-7 on contactor S, Fig. 10, completes a circuit from terminal 9 on coil Y, through coil Z on contactor S', across 13-7, up through interlock disk 7-8 and the shunt coil J', back down to and across interlock 5-12 on switch S' and to the other side of the line L_2, as indicated.

As previously explained, the shunt coil will draw up its core, as shown in Fig. 10. After the motor current has decreased to 100 per cent., the plunger in the series coil will drop, as indicated in Fig. 11, and complete a circuit directly from 9 on coil Y through coil Z and across interlock 13-7, and 7-8, up to and through contacts 8-5 on relay coil K', down through interlock 5-12 on switch S' and to the L_2 terminal of the line.

Energizing coil Z will close switch S' and short-circuit all the rotor resistance, Fig. 12. The rotor current at one instance is as indicated by the arrowhead. When switch S' is closed, interlocks 13-12 closes and 13-7 and 5-12 open. In opening 5-12 the circuit through coil Y is interrupted, which allows switch S to open, as shown, breaking the circuit between 13-7 on switch S', opens the circuit to the relay shunt coil J' and allows relay C' to take a normal position. Closing the circuit between 13-12 connects coil Z on switch S', directly across the line, the circuit being from L_1 side of the line to terminal 4 on coil X, on down to terminal 9 coil Z, through this coil and interlocks 13-12, up to L_2 line terminal, as indicated. When contactor S' closed, it caused the current to again increase 200 per cent., but as the motor accelerates to full speed, the current decreases to a value determined by the load. Thus an equipment of this type can accelerate a motor connected to a load, such as a plunger pump, without drawing excessive current from the line.

A description and simple application of alternating-current contactors and current-limit relays have been given in this and the previous article (July 10 issue), and these constitute the basis for all variations that are experienced. A reversing equipment contains everything shown in Fig. 5, but has in addition another line contactor similar to P. Sometimes overload relays are included, which give overload protection; sometimes triple-pole instead of double-pole contactors are used to entirely disconnect the motor from the line, and sometimes more contactors are used in the rotor circuit to short-circuit the resistor, but they are all a continuation of the principle described. With a very few exceptions, alternating-current magnetic control is very simple.

Tom Hunter, Hoisting Engineer

By WARREN O. ROGERS

We visit a hoisting plant, and Hunter explains the action of the reversing gear, brake mechanism and indicating dial. The reversing gear did away with the link motion and produced the same steam distribution when the hoist was running either over or under. The reason why Corliss valves are used instead of slide valves is made clear. Hunter also mentions a few things regarding overwinding and safety stops.

THE first hoisting plant we came to was No. 2 Champion, where a Nordberg duplex, or twin direct-acting, hoist was working. It had 32 x 72-in. cylinders and was equipped with an 18½-ft. drum having a winding capacity of 5031 ft. of 1⅜-in. round rope and hoisting a skip weighing 5300 lb. and a rock load of 6000 lb. The shaft was down 21 levels, or about 2100 ft. The engines were fitted with Corliss valves, and Hunter said that most of the hoists we would see were fitted with the same type of gear.

"There is one feature to notice on these engines," said Hunter, as we stood watching the ease with which the hoist was handled. "You will find that the most of the hoisting engines operating at the copper mines are equipped with a conical drum. At the depth at which hoisting is carried on, the weight of the rope often equals, and frequently exceeds, the weight of the ore, and in order to decrease the starting moment and the size of the cylinders, where hoisting can be done in balance, that type of drum is largely used. It is frequently necessary to hoist out of balance in either one or the other hoisting compartment. For that reason many of the drums are loose upon the shaft and are made fast for hoisting by a friction clutch."

"You said a while ago that most of the hoisting engines were equipped with Corliss valves. When we were at the coal mines, we found them to be equipped with slide valves. Of course the Corliss is the most economical engine, but if that is so, why don't they use them at the coal mines?"

"The reason is as simple as A B C," replied Hunter. "Coal mines are shallow, ranging from 200 to 1200 ft., and the average load handled outside of the rope and cage is, in the anthracite mines, about 6 tons, car and load, and the hoisting speed is between 700 and 1000 ft. per min. When coal hoists were first installed, the slide-valve engine was common and the Corliss engine had not been invented. When it was perfected, the slide-valve engine had gained a firm hold and has held it up to date. That type of engine is easily handled and is better suited for shallow mines than a Corliss engine, because after the load has been started, with a first-motion hoist, and practically all Corliss hoists are first-motion, the engine will make but a few revolutions with the cutoff in action before it will be necessary to shut off steam, and the economy in steam consumption will not balance with the first cost as compared with a slide-valve engine.

"There are a few Corliss hoists at coal mines, but here in the iron and copper country they are 'it.' I remember that Corliss hoists were tried in some of the shallow iron mines at one time, but being of the first-motion type, they had to be larger than necessary to keep the speed as low as possible. More than that, there was trouble in getting men that would take proper care of

them. That condition has disappeared, as you will find by the appearance of the copper hoists that we will see.

"Most of the ropes are round, but flat ropes are frequently used. I remember reading some time ago that in Belgium one flat rope was of 22½ in. breadth, 3 in. thick and weighed 18 tons; it tapered in breadth from the drum end. That cable, by the way, was at a coal mine.

"You have probably noticed the size of this engine (Fig. 1), but it is a small one compared to some we are going to see. The size of a hoisting engine depends upon the load to be raised, depth of the shaft, available steam pressure and the time occupied in hoisting. It is better to raise a heavy load slowly than a light load rapidly. In the latter case a considerable portion of the engine power is required to give the necessary acceleration to the skip, rope and load, with a consequently low working efficiency. An engine will exert about twice as many foot-pounds of work during the first 10 strokes as it does in the succeeding 10 strokes."

During Hunter's talk I had been watching the operation of four gears that moved each time the operator reversed the engine. Hunter, noticing my interest, started to explain before I had a chance to ask a question.

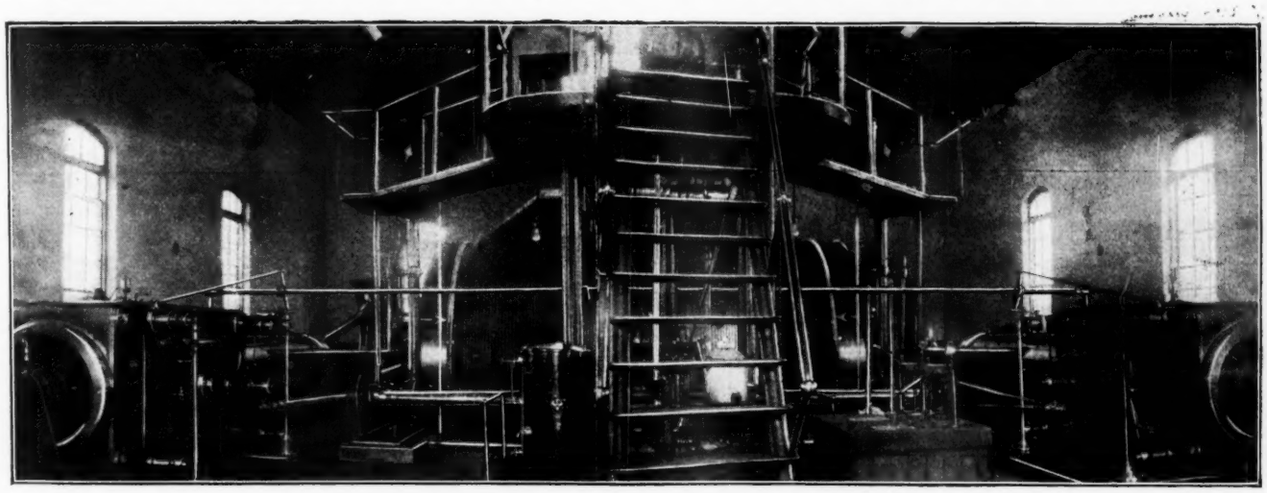


FIG. 1. CORLISS HOISTING ENGINE AT CHAMPION NO. 2

"This engine and all others of the same make are fitted with eccentrics, but instead of connecting with a link motion or to a wristplate, are directly connected to a crank of a gear shaft. You see, most hoisting engines run in both directions, and the steam distribution when running over or under should be the same. But it cannot be done with a link motion, such as is used on many reversing engines, and so a four-gear reversing arrangement is used."

While Hunter was talking, I had got the camera in position and took a shot of the gearing in its over and under running positions (Figs. 2 and 3).

"This gear," continued Hunter, "consists of a train of four gears with the two lower ones attached to stationary shafts. Here is a drawing of the layout (pointing to a blueprint, as in Fig. 4, that had been tacked to the tool cabinet). One shaft, *A*, is driven by an eccentric on the drum shaft and the other shaft *B* drives the wristplates. The two top gears are mounted on a carriage that swings them from one position to the other." See Fig. 4. "The top view shows the reverse gear set for the engine running under, the lower one shows it in the position for running over. "When the gear is operated it causes the gear on the left bottom shaft *B* to turn relatively to the gear on the opposite shaft *A* so that the angle of advance is the same for running in either direction. As the reversing gear causes the wristplate to move through its whole range of motion, the valves can always be picked up."

"How does the engineer operate the reverse gear; by steam pressure?"

"By means of either steam, air or oil. Steam is most convenient with most hoists. The steam apparatus consists of a steam cylinder at the bottom with an oil cylinder above. At the bottom of the steam cylinder (Fig. 4) is a valve *A* that is connected by the rod *B* to the valve oil-bypass valve *C*. The rod *B* is connected, as you can see, to a floating lever *D*, supported at one end by a rod *E* that is attached to the reverse carriage *F;* it is moved by the thrust cylinder piston rod. When the operating lever is shifted toward the right or away from the operator, the floating lever *D* is lifted, the inner joint acting as a fulcrum because the rod *E* is held stationary. Of course, that being the case, the rod *B* is lifted, which movement opens the steam valve *A* and the oil valve *C*, whereupon the piston is forced upward, at the same time lifting the lever *E*. When this occurs, the pin *H* becomes the fulcrum and the rod *B* moves downward to close the steam valve *A* and the oil valve *C*. With the steam shut off and the oil bypass closed by the valve *C*, the piston is locked in position: that is, the piston crosshead has been moved and locked in a position corresponding to the movement of the operating lever.

"You can readily see that the whole mechanism follows the movement of the operating lever, and just as soon as it ceases movement, the mechanism becomes locked in that position, so that the operator has the same control of it as though he were directly operating it by hand."

"I suppose the brake is operated in a somewhat similar manner," I suggested, as we moved around to the crankshaft and opposite the drum brake.

"Somewhat," replied Hunter. "There are really two types, band and post brakes, and I suppose both have their champions. You know a band brake is lined with wood and is secured at one end by a pin, upon which the maximum stresses come. In the post brake there are four pins upon which the stresses are exerted. I noticed a sketch of one of these brakes over on the tool cabinet that shows its construction." See Fig. 5.

We went over, and Hunter went on with his talk. "That," said he, "shows a gravity post brake operated by an air thrust cylinder. There are two sets of levers and drawbars for drawing the brake together. To my mind this arrangement gives the same pressure to the brake shoes all the way around, and a small movement only is necessary to clear the brake from the friction band. The brake is operated by a thrust cylinder and a floating-lever control. The air cylinder is at the bottom, and an oil cylinder is above it arranged similarly to the steam-control apparatus for the reverse gear. The air valve *A* and oil valve *C* are operated by the rod *B*, which is connected to the floating lever *D*, the other end of which is supported by the rod *E* that is attached to the deadweight *F* and moved by the thrust cylinder."

"When the operating lever is moved toward the left, the floating lever *D* rises with the point *G* as a fulcrum and the movement of the rod *B* opens the valves *A* and *C*. The air pressure raises the piston, which movement causes a corresponding movement of the deadweight and brake lever. At the same time the movement of the weight causes the lever *E* to lift and the fulcrum changes from *G* to *H*, so that the lever *B* moves in a reverse direction and closes the valves *A* and *C*, thus locking the oil piston; the brake mechanism is locked in a position corresponding to the movement of the operating lever. You see, the working of the apparatus is practically the same as that of the reversing-gear thrust cylinder. The movement of the deadweight increases or decreases the force exerted on the top and bottom connecting-rods between the two brake segments and thus regulates the grip of the brake shoes.

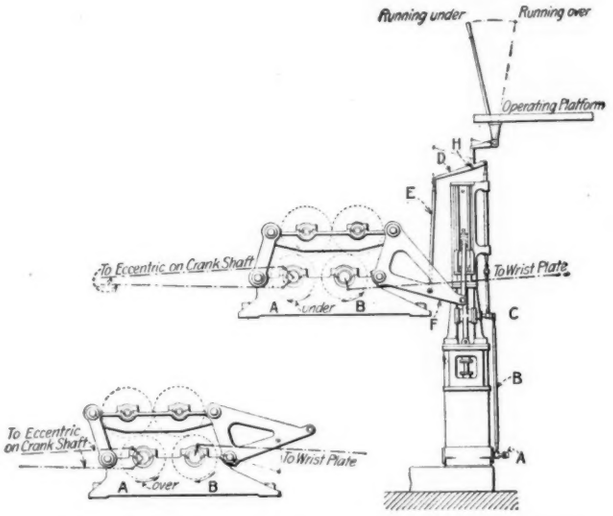


FIG. 4. DETAILS OF REVERSING GEAR APPARATUS

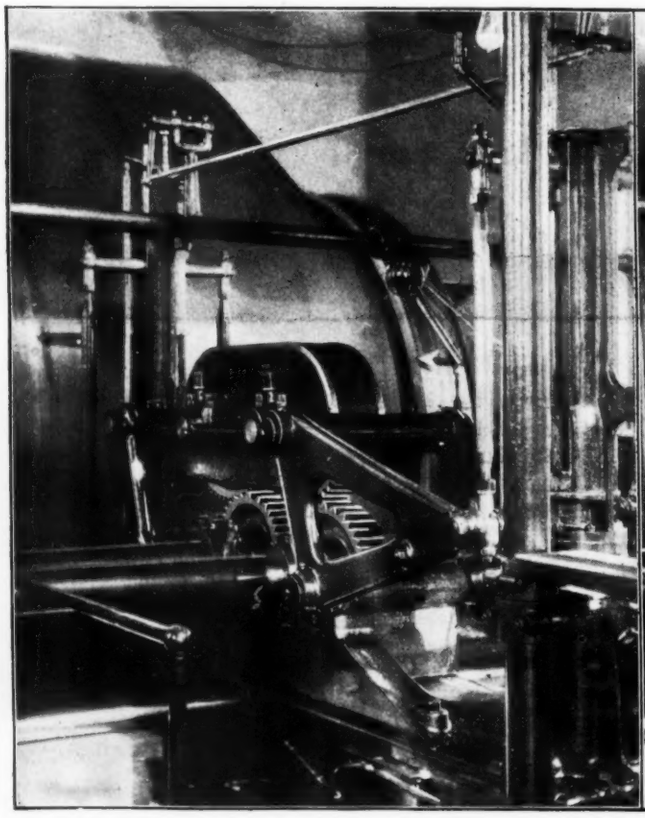


FIG. 2. REVERSING GEAR, ENGINE RUNNING OVER

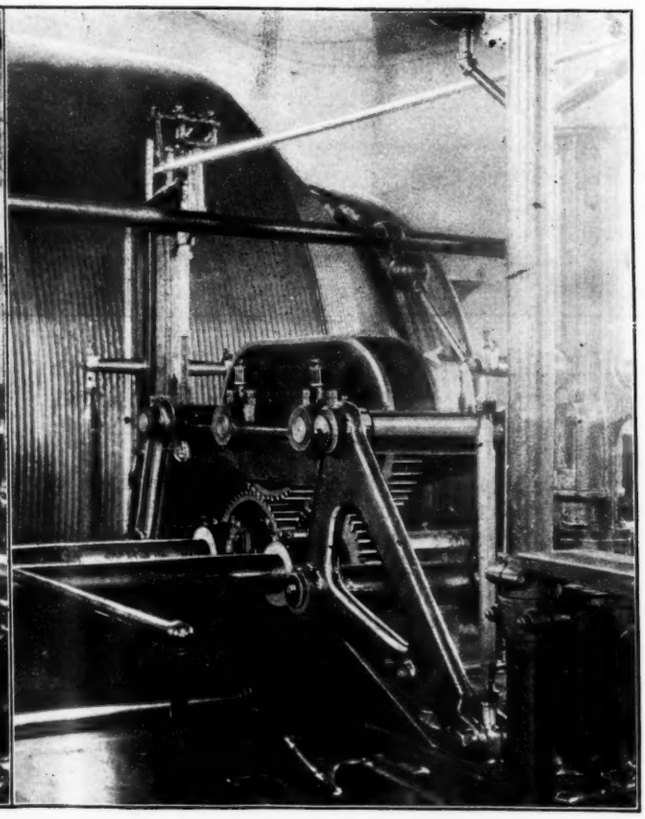


FIG. 3. REVERSING GEAR, ENGINE RUNNING UNDER

"You have doubtless noticed the size of the indicator dial," continued Hunter, changing the subject. "Each

figure represents a level in the mine, to the 21st level in this instance, and as the levels are about 100 ft. apart, the mine shaft is 2100 ft. deep. The pointer is operated by a gear on the layshaft of the reverse gear. As the skip is moved from one level to another, the pointer on the dial indicates just where the skip is, and you will notice that it does not take long for the skip to travel from one level to the next."

"I am noticing that," I replied, as I watched the pointer start from the 21st level. "What gets me is

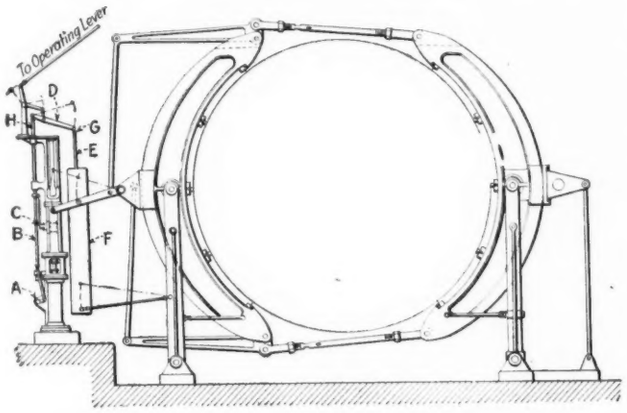


FIG. 5. POST BRAKE AND CONTROL APPARATUS

how the engineer can regulate the speed of the skip at the top of the rockhouse and not pull everything out through the side of the building."

"Well, if you will watch that dial you will see that a second, or fly pointer gets into gear when the skip gets to within about 175 ft. of the top. The fly pointer moves over the face of the indicating dial so much faster per foot of skip travel than the regular pointer

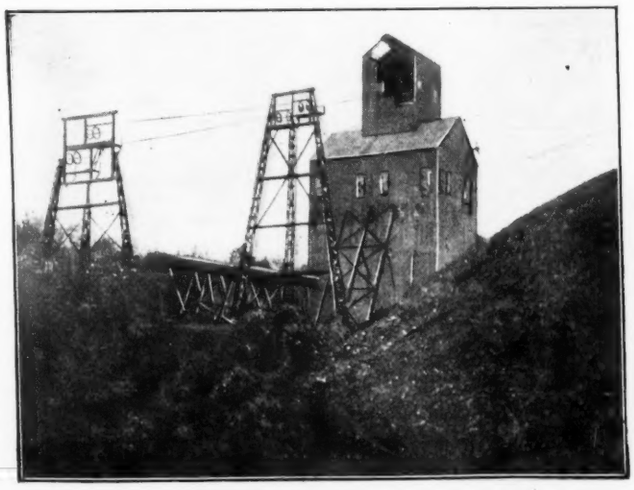


FIG. 6. ROCK HOUSE, SHOWING WHERE SKIP HAD BEEN DRAWN THROUGH THE SIDE

that the operator has no trouble in stopping the skip at the dumping point. In fact, they stop just right every time. In case the skip should be hoisted too far, there is trouble."

Later on we saw the effect of overwinding. For some reason or other the operator failed to stop the hoist at the proper time and the skip was pulled out through the side of the rockhouse, as shown in Fig. 6, doing considerable damage to the nearest sheavewheel tower.

"Most hoisting engines are equipped with safety-stop devices," continued Hunter, "but from what I can gather from the operators, they do not place much reliance on them."

"Why not?" I asked. "They operate all right at coal mines."

"Yes, I know they do, but you must remember that there is a much greater headroom with coal hoisting than with copper, where there are but a few feet between the skip in the dump position and the sheave wheel. Because of this and also because of the velocity at which the skip is traveling, the automatic, although acting properly and promptly, would not prevent overwinding.

"Another thing, the operators start and stop slowly and evenly. You have noticed that the engineers on some trains stop with a jerk, and that others come to an easy stop; the same is also true in getting a hoist in motion. A hoisting operator can do the same thing, but if he shuts off steam and applies the brake too suddenly, there is the danger that the rope will come out of the groove of the sheave wheel. This is because the momentum of the skip and rope is so great that the rope will become slack and jump the wheel.

"It is interesting to watch the signals. Some of the signal systems consist of a bell, others of a bell and red light, the light coming on each time the bell rings. With a half-ring the light remains lighted until the gong hammer is allowed to return for another ring, when the electric contact is broken."

"What do you mean by a half-ring?"

"A half-ring is one where the signal is given, say two rings but before the third ring is heard, the hammer is held suspended from the gong for a short period and then is allowed to fall for the final bell."

After inspecting the well-equipped machine shop, we made our way down the track toward the Trimountain mines.

Equalizing Piston Clearance

By Edw. T. Binns

A heavy knock developed in one of the engines, and examination of all bearings failed to reveal the cause. The normal position of the crosshead was marked by one center-punch mark on the crosshead, about midway of its length; and opposite this when the engine was on each center, there was a center-punch mark at each end of the guide bar. These were to test the adjustment of the connecting-rod length for running position.

The connecting-rod was disconnected, the crosshead and piston were pushed as far as they would go in each direction, and marks were put on the guide showing the "striking points." The distance between these points and the "travel points" (when connected up) was of course the "travel clearance." It was found that the piston rod had become slackened at the crosshead end thread and screwed in so that, in running, the piston struck the crank end head, causing the heavy knock. The clearance was equalized; and as an extra convenience a tram was made and center-punch marks were placed on the crosshead boss and on the rod, so that the distance could be "trammed" to prove whether the rod adjustment had changed or not. The question of clearance in the future will be an easy one.

The Stevens-Pratt Boiler

This proposed boiler consists of four sections with a total capacity as high as 5760 nominal rated horsepower. Each complete unit will have its own superheater, economizer and forced- and induced-draft fans. One chimney will serve the four sections.

THE tendency of modern practice in power-plant design has been toward the installation of large turbo-generators, each with its own battery of boilers of sufficient capacity to supply the turbine and its auxiliaries. Each turbine, with its boilers, in reality constitutes a separate unit, though the boilers of such units are cross-connected for emergencies.

As the size of turbines has been increased there has naturally been a corresponding increase in the size of individual boiler units, though the ratio of increase in boiler size has been nothing like as great as that in the case of turbines.

John A. Stevens, of Lowell, Mass., believing it advisable and practicable to install boiler units commensurate in size with the 50,000- and 60,000-kw. turbine units now being manufactured, has, in conjunction with some of the engineers of the Babcock & Wilcox Co., designed a boiler unit that, from the point of size, is comparable with the generator sets. These units, details of one design of which are shown in Fig. 2, may be built in capacities up to 5760 nominal rated boiler horsepower, based on a water-heating surface of 57,600 square feet.

The unit is, as indicated, a complete structure in itself, embodying four boiler sections, each with its own superheater, economizer, and forced- and induced-draft fans. One stack serves the four sections, and coal bunkers and ash-handling apparatus are common to each two of the four sections. Any number of the sections may be operated independently while inspection, cleaning or repairs are taking place in other sections.

Each boiler section, as shown in Fig. 2, is a Babcock & Wilcox boiler, 42 sections wide, each section made up of 15 tubes 20 ft. in length, all sections being connected to a cross-drum 60 in. in diameter. The water-heating surface per section is 14,400 sq.ft. or a total for the complete unit of 57,600 square feet.

With the superheater arrangement shown in Fig. 2, each superheater, located in the standard position for this design of boiler, contains 3588 sq.ft., or a total for the four sections of 14,352 sq.ft. of superheating surface. Each of the economizers shown in this figure contains 9200 sq.ft., or 36,800 sq.ft. of economizer surface for the complete unit.

The table shows the possible output in kilowatts from this design of boiler composed of sections of from 500 to 1450 rated horsepower each, at capacities of from 100 to 400 per cent. of nominal rating. This table is based on 30 lb. of water per boiler horsepower and a steam consumption for the turbine and its auxiliaries of 12 lb. per kw. From the table it appears that a boiler unit such as is here shown, with one section not in operation and the remaining three sections operating at 300 per cent. of normal rated capacity would supply steam for some 32,600 kw., while with all four sections operated at this same capacity, steam would be supplied for an output of over 43,000 kw. During peak-load periods, when 400 per cent. of rating could be developed for short intervals, the amount of steam generated would be sufficient for an output of 58,000 kilowatts.

It is of interest to consider the total capacity of one complete unit in connection with the floor space occupied. This space, not including coal bunkers or firing aisles, is only 90 ft. 6 in. by 84 ft. 4 in.

In the particular design shown in Fig. 2 the different boiler sections are fired under the mud-drum end. Such a setting not only gives a furnace of a desirable form, but lends itself readily to a direct connection between the boiler-section uptakes and the economizers. The economizer for each section, it will be noted, extends halfway across the section it serves and longitudinally over its section and the one directly behind it. The induced-draft fans shown are motor-driven. In an actual installation it is probable that duplicate drives would be supplied for each fan, preferably one turbine

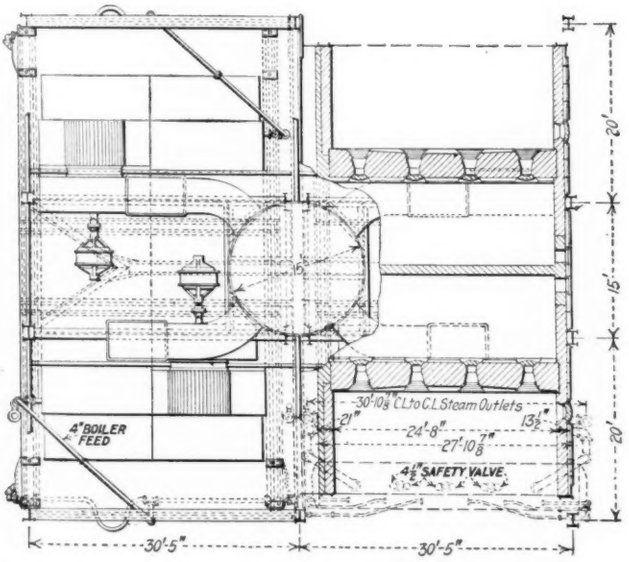


FIG. 1. PLAN OF GENERAL ARRANGEMENT

and one motor, on opposite sides. Such an arrangement would assure continuity of service.

The economizers are provided with soot pockets below the economizer headers. The soot removed from the economizer surface by soot blowers collects in these pockets, from which it is removed by conveyors.

The uptakes from the economizer into the common stack serving the four sections enter at four points at 90 deg., about as shown in Fig. 1. The complete boiler unit is inclosed in an insulated steel casing, thus minimizing air leakage and radiation losses.

The coal- and ash-handling arrangements are simple. When, as in Fig. 2, the approach to the power house is on what is indicated as the ground level, coal cars are run under the boiler where they discharge on a vibrating crusher (see small sketch in left top Fig. 2) from

which the coal is carried by conveyors to the coal bunkers. From the bunkers the coal is led to the stoker hoppers through chutes, as shown. Under the rear of each stoker is an ash hopper from which the ash and clinker are discharged into ash or coal cars, which use the same tracks as those on which the coal is brought into the plant.

Under certain conditions, when the approach to the power house is at an elevation, a spur track might be run above the coal bunkers and the coal discharged direct from the cars into the bunkers.

The boiler is operated from a working platform at the top, from which, by the use of the modern boiler attachments and boiler-room appliances, every detail of the operation of the complete unit will be under the direct supervision of the engineer in charge. This unit as a whole makes a complete self-contained high-pressure, large-capacity, economically handled installation.

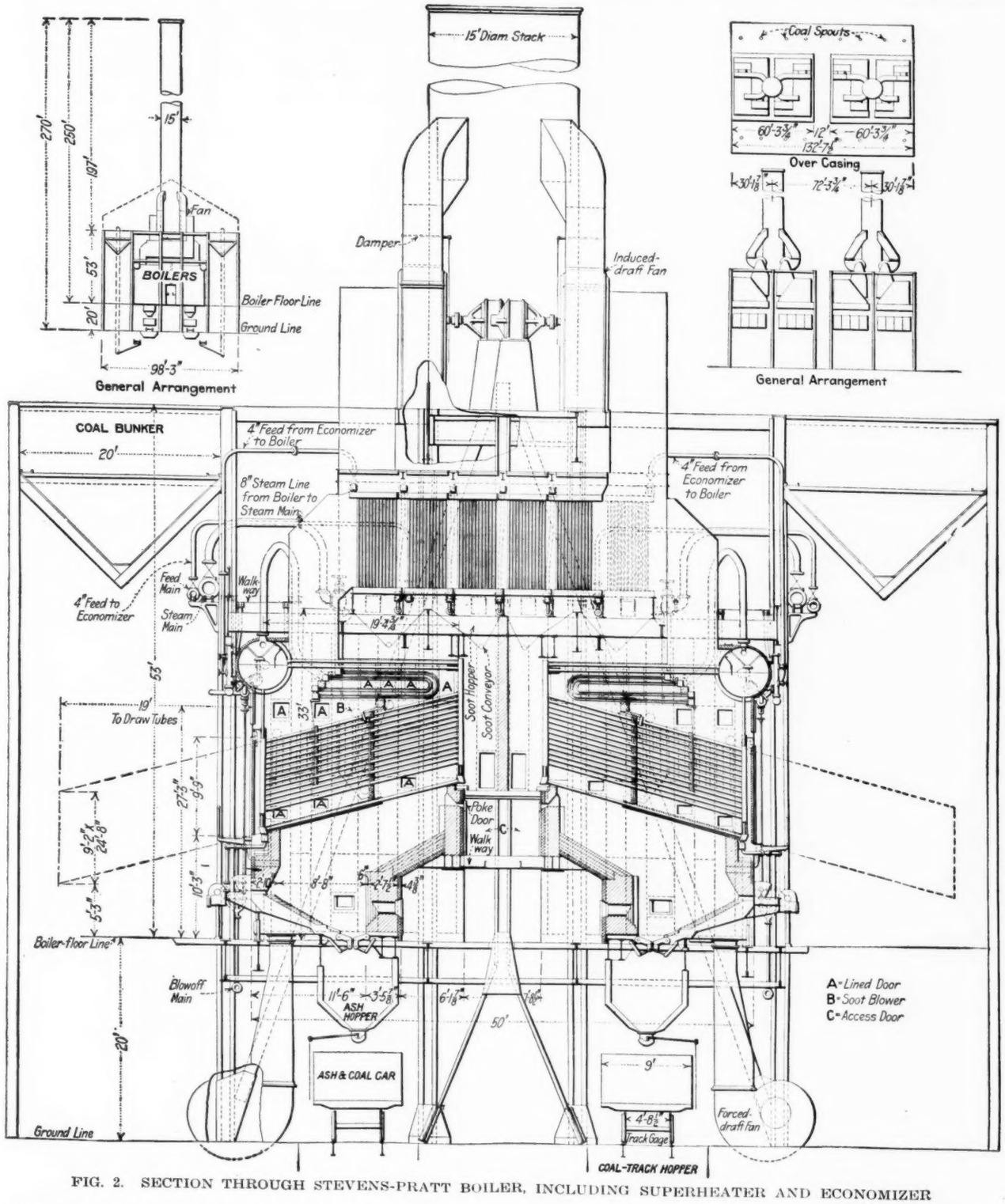


FIG. 2. SECTION THROUGH STEVENS-PRATT BOILER, INCLUDING SUPERHEATER AND ECONOMIZER

The boiler is designed primarily to make unnecessary the expense of an elaborate boiler-room building. All that is necessary to complete the housing of one or more of these units is the filling in of the space between the

BABCOCK & WILCOX, STEVENS-PRATT BOILER

Possible Output in Kilowatts, allowing 30 lb. Water per Boiler Horsepower per Hour and 12 lb. Steam per Kilowatt-hour, Including Auxiliaries in Turbine Plant

350 Lb. B. P.; 250° F. Superheat

Size of Sections in Boiler Hp.	No. of Sections in Operation	Per Cent. Rating of Sections 100 Kw.	150 Kw.	175 Kw.	200 Kw.	250 Kw.	300 Kw.	400 Kw.
500	4	5,000	7,500	8,750	10,000	12,500	15,000	20,000
	3	3,750	5,625	6,562	7,500	9,375	11,250	15,000
750	4	7,500	11,250	13,125	15,000	18,750	22,500	30,000
	3	5,625	8,437	9,844	11,250	14,062	16,875	22,500
1,000	4	10,000	15,000	17,500	20,000	25,000	30,000	40,000
	3	7,500	11,250	13,125	15,000	18,750	22,500	30,000
1,350	4	13,500	20,250	23,625	27,000	33,750	40,500	54,000
	3	10,125	15,187	17,719	20,250	25,312	30,375	40,500
1,450	4	14,500	21,750	25,375	29,000	36,250	43,500	58,000
	3	10,875	16,312	19,031	21,750	27,187	32,625	43,500

coal-bunker supports with panel walls and the roofing over of the top. From this viewpoint, that is, from the viewpoint of the complete boiler end of the modern power plant, such an installation would compare favorably in price with the modern station, with its building.

Operation of Marine Evaporators

BY CHARLES H. BROMLEY

The salinometer is a special hydrometer graduated to show the density of a solution, as of salt in water, in terms of the density of average sea water. In distilled water the zero of the scale upon the stem will be at the water line. In ordinary sea water at 1. When sea water is used for feed its density is increased by the boiling off of the water and the density must not be allowed to exceed three times that of average sea water; that is, must not be allowed to become so dense that the reading upon the salinometer when it is immersed in a sample of it will exceed 3.

The following is a description of the Reilly evaporator, extensively used. The directions will apply generally to all evaporators. As seen from Fig. 4, the evaporator is made up of a number of small copper coils held vertically between manifolds and so arranged that the entire tube surface may be withdrawn from the shell of the evaporator for cleaning and inspection purposes. Steam for evaporating the salt water flows through these coils, which are submerged in the salt water which is within the shell. The vapor goes off to a still, or condenser, the salt remaining in the evaporator. The water in the evaporator shell should never be allowed to go above 3½ thirty-seconds salinometer.

Two typical layouts of evaporator equipment are shown in Figs. 1 and 3, the latter being the installation used for supplying makeup boiler-feed water and the former that used for furnishing water for cooking and drinking purposes. Fig. 2 shows the pressure regulating valve.

Before putting the evaporator in service, subject the coils to full steam pressure to determine if there are leaks which will allow the passage of boiler steam into the water to be evaporated. See also that the nuts that hold the coils to the manifold are not drawn up too tight. Where a special distiller is used to condense part or all of the vapor for drinking, cooking or washing purposes, start the distiller pump, circulating only enough water to take care of the vapor that will come from the evaporator. Close the vapor valves in the line to the distiller and main condenser and then crack it off the seat about one-eighth turn. Other valves on the vapor line should be set so as to divert the vapor as desired. The salt-water feed pump is started and the evaporator filled to a level that will show not over 2 in. of water in the gage-glass. The salt-water pumps should now be stopped. When the evaporator is being put into service for the first time after installation, the bypass of the steam trap should be opened and steam admitted until the gage hand is lifted just off the pin. Run this way for about fifteen minutes to clean out the coils and traps. All pet-cocks on the manifold drains should be opened during this time.

As salt water tends to foam much more violently than fresh water, the water level in the gage will rise considerably when the water is heated. When the pressure, the vapor pressure, is about 1 lb. or 2 lb. on the gage, open the vapor valves slowly. Now close the bypass at the steam trap and turn on the steam slowly to the coils, increasing the pressure to about 20 lb. gage. Adjust the vapor valves so that the gage reads 5 lb., which will then give about 30 deg. temperature difference to the coils, which is the proper condition for moderate operation at about one-third capacity. Watch the stop-cocks on the manifold drain, which should be open so as to bleed air and vapor continuously.

It is most important that the operator know that the apparent water level in the gage-glass is at least 12 in. below the actual water level in the shell when operating the evaporator at two-thirds of rated load as above. To insure that the coils are fully submerged in the brine, the apparent water level in the gage-glass should be one-half way between the bottom and top manifolds of the evaporator.

Do not hesitate to blow down part of the water in the evaporator if you see it suddenly rising too high in the glass when starting. Best results will be had when the steam pressure, the vapor pressure, the water level and the air bleeding are all maintained uniformly.

The conservative rated capacity is based on a difference of 90 deg. F. between the temperature of the vapor and the temperature of the steam in the coils for single-effect operation. Practically the same capacity may be secured with this temperature difference for vapor pressures, varying from atmosphere to 25 lb., but

TABLE I. DESIRABLE STEAM PRESSURES FOR DIFFERENT VAPOR PRESSURES

Steam Pressure to Coils, Lb. Gage	Vapor Pressure, Lb. Gage	Steam Pressure to Coils, Lb. Gage	Vapor Pressure, Lb. Gage
55	Atmosphere	75	6
58	1	78	7
61	2	80	8
65	3	85	9
68	4	87	10
72	5		

the operation of the evaporator is improved if a high vapor pressure is carried. To secure the rated capacity the salt water must be blown down regularly and never permitted to exceed, as stated before, 3½ thirty-seconds salinometer. Table I gives the desirable steam pressures for steam entering the coils for different vapor pressures.

Table II indicates that a high vapor pressure reduces the volume of vapor that an evaporator must produce, giving smooth operation. It is evident from the table that at 8 lb. gage, the volume of vapor produced in an

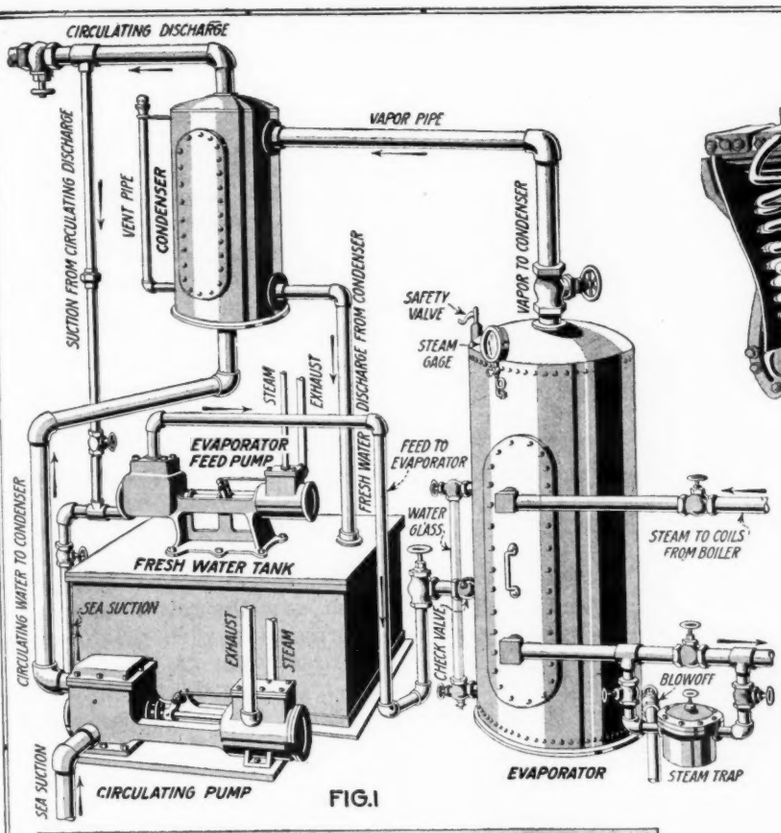


FIG.1

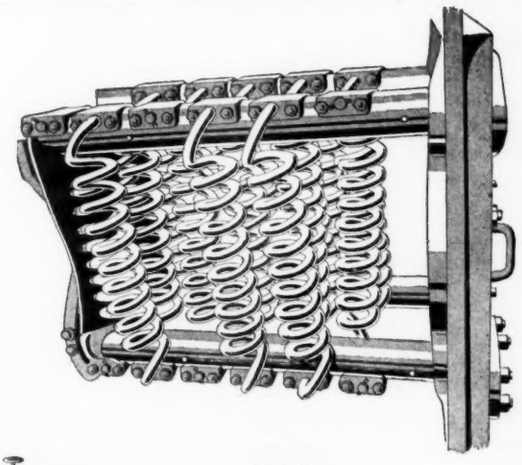


FIG.4

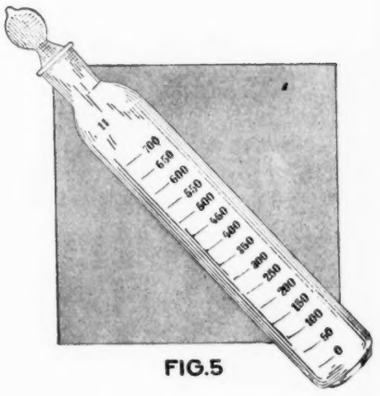


FIG.5

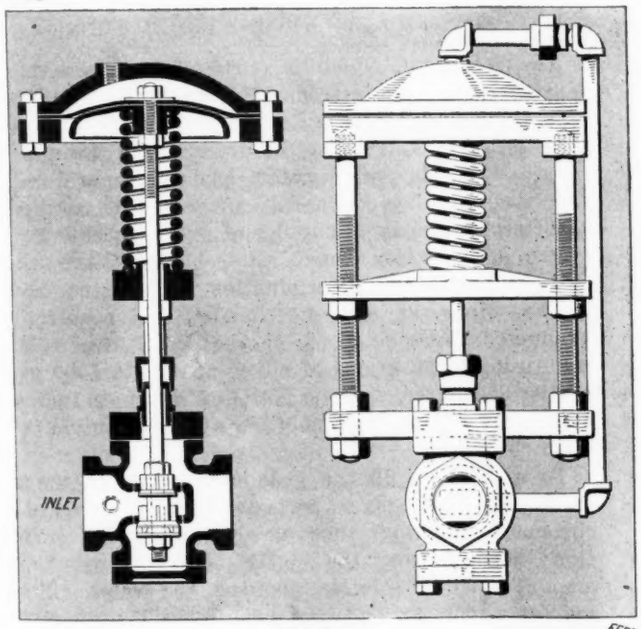


FIG.2

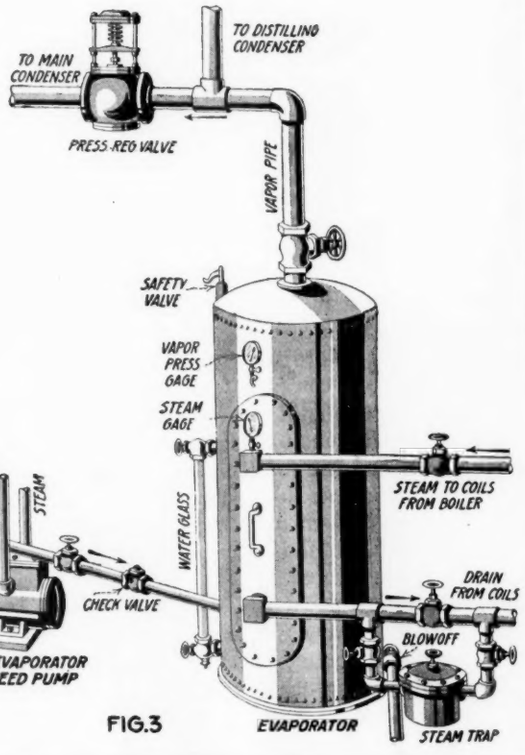


FIG.3

FIGS. 1 TO 4. REPRESENTATIVE LAYOUTS OF MARINE EVAPORATORS

Fig. 1—Distilled-water evaporator. Fig. 2—Pressure-regulator valve. Fig. 3—Boiler-makeup evaporator. Fig. 4—Evaporator coils and manifold. Fig. 5—Graduated bottle

evaporator will be only two-thirds of the volume of the same weight of vapor at atmospheric pressure.

It is further advisable to maintain a vapor pressure of from 8 lb. to 10 lb. under operating conditions, obtaining this by throttling the vapor valves immediately attached to the evaporator.

TABLE II. VAPOR PRESSURE, TEMPERATURE AND VOLUME

Press., Lb. Gage	Temp., Deg. F.	Volume of 1 Lb. of Steam, Cu. Ft.
Atmosphere	212	26.79
1	215.3	25.23
2	218.5	23.80
3	221.5	22.53
4	224.4	21.40
5	227.2	20.38
6	229.8	19.45
7	232.4	18.61
8	234.8	17.85
9	237.1	17.14
10	239.4	16.49

Table III shows the proportion of salt in the water of the principal seas of the world. This table also shows the total feed and total blowdown per thousand gallons of pure distilled water produced with a blowdown at 3 thirty-seconds salinometer density.

As temperature will influence the salinometer reading, the engineer should know that fresh water at 200 deg. F. will permit the salinometer to sink to the zero mark. Average salt water from the ocean at 200 deg. will allow the salinometer to sink in the water to about 1¼ thirty-seconds on the salinometer scale. Should the water be colder than 200 deg., the salinometer will indicate a higher density. Thus if the water is 190 instead of 200 deg., the instrument will be in error about ⅛ of 1 thirty-second, and if the water is only 120 deg. the reading will be about 1 thirty-second too heavy. In other words, water that is really at 2 thirty-seconds would show 3 thirty-seconds on the salinometer. This shows the importance of measuring the density of water immediately after it is drawn from the evaporator. Usually the water is drawn off in a vessel called the salinometer pot. More will be said later about determining the chlorine content of water.

TABLE III. PROPORTION OF SALT IN WATER OF PRINCIPAL SEAS.

Sea	Parts by Wt. of Salt per 1,000	32nds	Per 1,000 Gal. Distilled Water: Gal. of Feed Water	Gal. Blowdown at 3/32 Density
One Thirty-second...	31.25	1.00	1,500	500
Atlantic Ocean				
41° N. 36° W.....	38.40	1.23	1,695	695
North Atlantic.....	42.60	1.36	1,830	830
Atlantic at Equator.	39.42	1.26	1,727	727
South Atlantic.....	41.20	1.31	1,782	782
Pacific Ocean				
25° S. 93° W.....	35.25	1.12	1,595	595
Mediterranean Sea..	39.40	1.26	1,725	725
British Channel.....	35.50	1.13	1,605	605
German Ocean.....	32.80	1.05	1,535	535
Irish Sea.....	33.76	1.08	1,560	560
Baltic Sea.....	6.60	0.21	1,076	76
Black Sea.....	21.60	0.69	1,295	295
Arctic Sea.....	28.30	0.91	1,435	435

There are three methods of blowing down the evaporator—the continuous blowdown, the intermittent partial blowdown and the intermittent complete blowdown. Intermittent complete blowdown means emptying out the evaporator shell entirely, preferably with the blowdown wide open, so that any sediment or loose scale particles may be ejected with the blowdown water. Intermittent partial blowdown, which means the opening of the blowdown valve for brief periods at reasonably short intervals, is common practice when operating boilers. For this reason many engineers use this method for blowing down evaporators, forgetting that the evaporator, unlike the boiler, may be emptied entirely. The intermittent complete blowdown is therefore the best method for blowing down evaporators.

It should not be necessary to caution the engineer to see that the gage-glass valve, the coil drains and the air pet-cocks are free and unobstructed; otherwise it will not be possible to get rated capacity from the evaporator.

To shut down the evaporator, close the main steam valve, then close the sea-water feed valve, after which open the blowdown valve wide. Close the vapor valve. After blowing down, close the blowdown valve and fill the evaporator shell so that the coils are completely submerged, leaving the evaporator to stand full of water.

With this evaporator, scale may be cracked off the coils by sudden and violent temperature changes, which are produced as follows: Close the steam valve to the coils and blowdown evaporator. Close the blowdown valve. Feed cold water to the evaporator until the coils are immersed above the top manifold. If necessary, this should be repeated until the manifolds are cold to the touch. With the shell full of water, open the steam valve suddenly and keep it open until a pressure of at least 40 lb. shows on the gage. Allow this pressure to remain in the coils only long enough to heat them (about one minute), after which close the valves. Now blow down the evaporator by opening wide the blowdown valve. This done, feed cold water to the evaporator until the coils are covered. Repeat this operation until the scale is cracked off. A few operations will do. After the scale is cracked off, shut off the steam to the coils and open the bypass on the steam trap. Be sure to leave the evaporator full of water.

Determining Amount of Chlorine

The following, which is particularly interesting to marine engineers, is from "Marine Steam," published by the Babcock & Wilcox Co.: The salinometer is not a very accurate instrument for determining the quantity of sea water in boiler water, but the apparatus here described gives a convenient and accurate method of ascertaining the exact number of grains of chlorine per gallon in the water tested. It is based on the scheme for the volumetric determination of chlorine devised by Fr. Mohr, an eminent chemist, and requires one graduated bottle (Fig. 5), one bottle of silver solution containing 4.738 grams of silver nitrate to 1000 grams of distilled water, and one bottle of chromate indicator, which is a 10 per cent. solution of pure neutral potassium chromate.

To make test, fill the graduated bottle to the zero mark with the water to be tested; add one drop of the chromate indicator; then slowly add the silver solution; keep shaking the bottle. On nearing the full amount of silver solution required, the water will turn red for a moment, and then back to yellow again when shaken. The moment it turns red and remains red, stop adding the silver. The reading on the graduated bottle at the level of the liquid shows the amount of chlorine in grains per gallon. For example, if a permanent red color is shown when the level is midway between 150 and 200, there are 175 grains of chlorine per gallon.

The principle of the process depends upon the fact that if some of this silver solution be dropped into water containing a chloride, a curdy white precipitate of chloride of silver will be formed. If there is also present in the water enough potassium chromate to give a yellow color, the white precipitate will continue to form as be-

fore, owing to the silver having a greater affinity for chlorine than for the chromic acid in the chromate. But, at the moment when all the chlorine in the sample has been converted, the silver will attack the yellow potassium chromate, and chromate of silver will be formed, which is red in color. The amount of chlorine present is, therefore, shown by the amount of silver solution required to convert it all to silver chloride, and the determination of the exact point at which the chloride precipitate ceases to form is greatly facilitated by observing when the chromate indicator turns from yellow to red.

It is not necessary to add the silver solution until the color becomes very red, as the delicacy of the reaction would be destroyed, but the change from yellow to yellowish red must be distinct and must not change on shaking. The sample of water to be tested should be neutral, as free acids dissolve the silver chromate. If it should be acid, neutralize by adding sodium carbonate. Slight alkalinity does not interfere with the reaction, but should the sample be very alkaline, it may be neutralized with nitric acid.

Should it happen that the color does not change within the limits of the graduations, the sample may be tested by diluting with distilled water. For example, add three parts of distilled water to one part of the sample. If then, on testing the mixture, the color changes at 200, the number of grains per gallon in the original sample will be four times this reading, or 800 grains.

The chlorine should be kept down to the least possible amount—say below 50 grains per gallon—as the nearer the boiler water is to fresh water the safer the boilers are against corrosion.

If the water is so corrosive as to be acid, blue litmus paper, which has not been allowed to become deteriorated through exposure to the atmosphere (keep in a bottle with a glass stopper), will turn slightly red. If a change in color is not apparent at once, it should be allowed to remain in the solution a few minutes and then carefully dried and compared with an unused sample of litmus paper.

Another method is to put into it a few drops of a chemical called methyl-orange. This methyl-orange gives a yellow color so long as the water is alkaline, but if turned pink, it shows that the water is acid, and therefore highly corrosive. This latter test is more sensitive than the litmus-paper test and should be used in preference.

A testing kit containing the graduated bottle and the solutions referred to, also strips of blue and red litmus paper, packed in a padded box, is supplied by the Babcock & Wilcox Co. with all boiler installations intended for salt-water service.

Alternating-Current Oil Switch for Reversing Service

To meet the increasing demand for a switch for use with small alternating-current motors which can be started by connecting them directly to the supply circuit, the Crocker-Wheeler Co., Ampere, N. J., has developed an oil switch of the cylindrical type for the service on two- and three-phase motors up to 10 hp., 220, 440 and 500 volts.

The practical design and rugged simplicity of this switch is clearly indicated in the accompanying illustrations, which show the switch complete at *A*, cover *C*, the switch proper *S*, and the oil tank *T*. The moving contacts *M* are mounted on a fiber-insulated rod. These moving contacts make contact with the center row of stationary contacts and one of the outside rows of contacts when the switch is in the forward position, and with the center row of stationary contacts and the other outside row of contacts when the switch is in the reverse position. This scheme gives a very large break on two points per pole.

The moving contacts are free to turn on their axis so that a new contact surface is continually presented to the fixed contacts, thereby prolonging the life of the switch. The tank holding the oil in which the contacts are immersed is bolted to the upper part of the switch. Oil cannot splash into the wiring chamber under ordinary conditions of use.

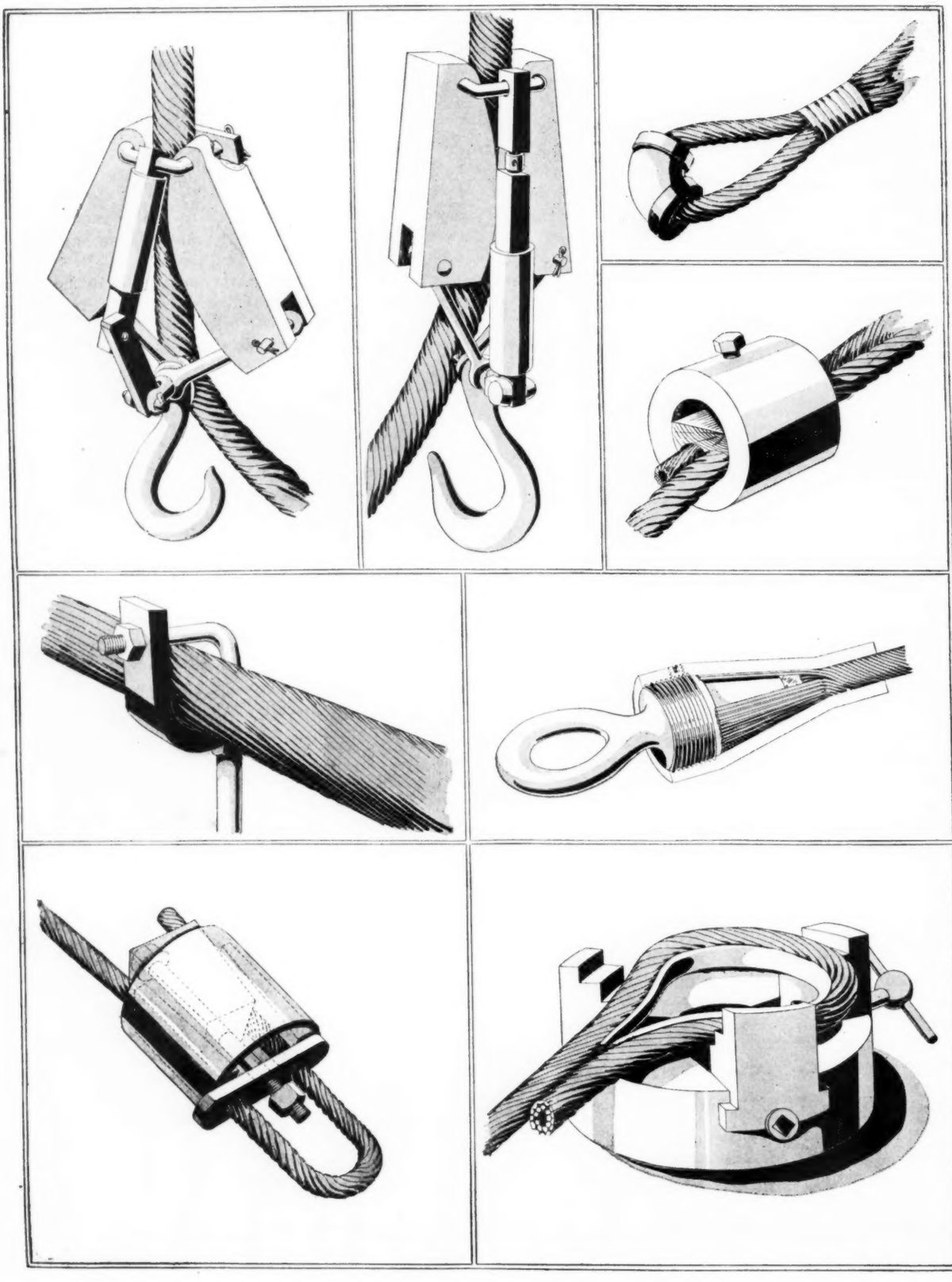
A removable cover permits easy access to the terminal board, which is provided with heavy binding posts. These switches can be furnished with or without latches for holding the contacts securely in the desired position.

ASSEMBLY AND PARTS OF REVERSING OIL SWITCH

No latches are needed where the switch handle is operated by an arm or rod for controlling from a near-by point. Such an arm or rod has sufficient friction with its supports to serve for holding the switch contacts in the proper position. Indications of "off," "forward" and "reverse" positions of the operating handle are cast in the case of the switch. Heavy lugs are provided for mounting these switches on a wall, machine or post. They can be arranged for single-throw operation, either right-hand or left-hand assembly.

The gasoline production in the United States has increased from about 400,000,000 gal. in 1907 to about 2,000,000,000 gal. in 1916. It is estimated that 2,500,000,000 gal. will be produced in 1917 and that 2,000,000,000 gal. of this production will be used in motor vehicles alone.

Cable Fastenings



Editorials

Treat All Alike

WE ARE living in unprecedented times. Many things, the legality of which would be questioned under normal conditions, are now being done under stress of national necessity. The Government has commandeered the nation's shipping; it has virtually taken over the operation of the railroads; through the Priority Board it exercises control over most industries; it has sought to fix prices and is about to put into effect drastic food measures.

And it is right that the Government should do these things. The public has been quick to realize that national welfare is paramount to individual rights, and even those whose business has been most affected have, as a rule, gracefully acquiesced in the decisions of those in authority.

But if it is right to supervise the distribution of raw materials, to fix the price of the manufactured product, and in a sense to limit profits through the imposition of an excess profit tax, then is it not fair that labor which goes into the manufactured product should also come in for some measure of regulation? Of course it is to be expected that with greatly increased demand and a decreased supply of labor, the law of supply and demand will work toward higher wages. Whether this so-called law should be permitted full sway in war times is a problem that must be met, just as in the case of commodities.

However, when labor attempts to hold the Government by the throat, as it did last week by threatening to call a strike at all cantonments and navy yards because one of the contractors, in an effort to rush the work, had hired some non-union carpenters, it is high time for stern measures. This was done in the face of the fact that many of these men, with double pay for overtime, are earning from fifty to sixty dollars per week.

The prime consideration at the present moment is to get things done, and anyone who willfully obstructs such work is giving aid to the enemy. The law is specific as regards the punishment for such offenders, and if examples were made of a few of these obstructors, whether they be labor leaders or "willful" members of Congress, the general effect would be wholesome.

That any decisive measures will be taken is unlikely. In the instance referred to the contractor was compelled, presumably under pressure from Washington to surrender completely to the demands of the union. Political pampering of labor in lieu of settlement of such problems on a just basis will serve only to aggravate the issues and is likely to breed more trouble for the future.

Starting Induction Machines

THE polyphase induction motor has enjoyed the reputation of being the simplest of motors as to construction and requiring the least attention and maintenance. However, when it is considered that the motor is supplied with two or more alternating currents out of step with each other, it at once becomes apparent that many of the electrical and magnetic conditions involved in the operation of the machine must be complicated. Probably on account of the simple construction of the machine, this fact has not been appreciated to the extent that it would have been if the machine were more intricate.

A letter, "Ammeter Needle Bent," printed elsewhere in this issue, sets forth the general opinion of the operating man with respect to starting an induction motor. Although no doubt the diagnosis given as to the origin of the trouble is correct in this case, it is not the only condition under which a heavy current inrush can be caused when the motor is connected from low- to high-voltage connections on the compensator. To bring this fact to the reader's attention, there is also published in this issue an abstract from a paper, "Transient Conditions in Induction Machines," which was presented before the American Institute of Electrical Engineers. In this paper the author shows that a number of conditions can be obtained which will cause a current inrush, when changing from low to high voltage on a compensator, that may be almost double that which can be obtained when the motor is started from standstill by connecting it directly to full voltage. The fact that is usually overlooked in this respect is that the motor continues to generate an electromotive force, for a period after it has been disconnected from the line, due to the flux not dying out in step with the current. This is influenced by the number of poles and the size of the motor. The larger the motor and the smaller the number of poles the more pronounced the effect. The author calls attention to a case where a fifteen-hundred-horsepower four-pole twenty-five-cycle motor maintained sufficient voltage in the stator windings to keep incandescent lamps luminous for seven seconds.

The result of this condition existing in the motor, for a period after it is disconnected from the line, is a relation between induced stator voltage and line voltage similar to two alternating-current generators operating separately; their voltages may be in step at one instant and out of step the next. If the switch is closed to connect the alternators in parallel, when they are in step the cross-currents will be small and when out of step the cross-currents will be very high. Likewise, when an induction motor is connected to the circuit after

being disconnected for a short period, the current obtained depends to a large extent upon the state of synchronism that exists between the induced voltage in the stator and the line voltage. A moment's reflection on this point alone, although there are other conditions that tend to produce the same effect, will show that the best starting conditions will not always be obtained by bringing the motor up to near synchronous speed on low voltage, subsequently disconnecting it, and then connecting it to line voltage.

While practical experience taught both controller and motor designing engineers, relatively early in the development of the industry, that such conditions existed as are pointed out in this paper, and steps have been taken in the design of motor and control equipment to prevent these undesirable effects as far as practicable, it is felt that a better understanding of these phenomena by the operating men will prevent many wrong interpretations of effect observed in the operation of this class of apparatus.

The Opportunities of the Engineer

THE Society for the Promotion of Engineering Education, at a recent meeting at Washington, considered the question of the present and prospective supply of engineers. It is pointed out that, aside from the present extraordinary demand for engineering ability, there will be exceptional opportunities for engineers after the conclusion of the war. The larger part of the civilized world will have to be reconstructed. Industrial plants, bridges, railroads are going to rack and ruin, even when they escape destruction. War overworks them and prevents repair. The demand for engineers will greatly exceed the supply. When war broke out, practically all the engineering schools abroad shut down, and engineers in Europe have been slaughtered wholesale. Hardly more than half the usual number of young Americans are now enrolled as students of engineering, whereas there should be twice that number.

What is the remedy? One would discourage enlistment among students of engineering; another would put those who are drafted into the engineering corps; still another would provide Government aid for young men willing to enter a technical school. The *Chicago Tribune* advocates proselyting. "Tell every boy of your acquaintance," it says, "that engineering will be the best-paid profession for at least ten years after the war."

This threat to glut the profession calls forth a protest from the second vice president of the American Association of Engineers. The sentence quoted, he says, "sounds too optimistic to us who have borne the heat and burden of long years of ill-paid service. We who know that the engineer is generally regarded as a necessary nuisance, who has been barely granted a living wage; we who know that there are engineers whose education has cost them thousands of dollars; men who have mastered the science and whose compensation for knowledge, experience and faithful work is on the scale of wages paid to barely skilled labor, can hardly believe that even war will bring him into his own."

Making all allowance for the note of pessimism and the strain of self-interest which runs through this protest; recognizing that the writer offers no solution of the threatening shortage, but rather seems to welcome it as a possible assuagement of the condition of those engineers who survive to profit by the increased demand for their service; recalling that there are some engineers who are generally regarded otherwise than as "necessary nuisances" and who have made a fairly good living, it is a fact the engineer is at a disadvantage in recognition and emolument with the financier and his executive representative or even with the successful salesman. There may be a time when the credit and opportunity of the man who *can* will be at least equal to those of the man who *has*.

The Bureau of Statistics and Information of the New York State Industrial Commission announces that the light, heat and power industry increased both its number of employees and its wage payment five per cent. in June as compared with May, thereby establishing new high records in both respects. As compared with June of last year, there were seven per cent. more workers and thirteen per cent. more paid in wages. The war has increased the work in this industry rather than reduced it. One of the lessons to be learned from these figures is that the more responsible engineers and skilled workers should not be drafted, and they should be permitted to enlist only after inquiry as to whether they would be more valuable at the front or camps than on their regular jobs. It is gratifying to see the Government doing all it can to avoid the mistakes in this direction that England made in the beginning. We understand that some men in the engineering offices of this industry were sent back from officers' training camps because the Government believed them more useful in their usual occupations.

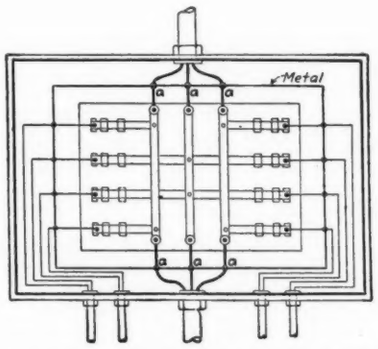
To serve our readers who are serving our Country, the publishers of *Power* will allow the domestic subscription rate to apply on copies sent to subscribers abroad on the Nation's business. Special arrangements will be made to supply such readers promptly and regularly. Tell us where to mail your copies so that you will not lose touch with your business and professional interests while you are in touch with the enemy. Cut off from your business associates, it is more than ever important that you be not cut off from technical news.

Delegates to the N. A. S. E. convention at Evansville in September should send us their photographs. Now!!! We want to print them in our convention daily, and they can have the electrotype gratis after we have used it, for printing upon their own cards, letterheads, etc. A postal-card size, head and shoulders only, is what we need. Please write your name and the name and number of the association that you represent plainly on the back of the photograph.

Correspondence

Fittings For Alternating-Current Conductors

I have carefully read the article, "The Installation of Motors," in Apr. 24 issue of *Power*, and also the criticisms, "Iron Fittings Caused Voltage Drop," made by W. F. Shedinger in July 10 issue. The installation of conductors as indicated in the original article is strictly in accordance with the National Electrical Code. However, I believe that in several places the question of potential drop in alternating current circuits transmitting large currents, has been investigated by a number of different central-station companies. We have received objections from one of the electric-light companies in this city with reference to the use of cabinets con-



SHOWING CONDUCTORS PASSING THROUGH METAL PANEL BOX

structed as shown in the figure, due to the fact that each feed wire is carried through a separate opening, as at *a*, in the inner metal partitions; and although the metal is not over $\frac{1}{16}$ in. thick, it is claimed that considerable loss of voltage occurs.

I believe that the question which has been raised by Mr. Shedinger is an important one and should be given careful consideration at the next meeting of the Electrical Committee of the National Fire Protective Association.

J. C. FORSYTH, Chief Inspector,
New York Board of Fire Underwriters.

New York, N. Y.

Cure for Rattling Governor

Replying to C. B. Hudson's criticism and question, "Why not bush the links and make new pins?" etc., in the issue of July 31, page 161, regarding my suggestions in the issue of June 5, page 778, I would remind him that not every engineer has the means at hand or the funds at his disposal for such work. Besides, it is hard to tell just what degree of "rattle" he considers permissible before such work is justified, while the "anti-rattle" adjustment is always in order and is like the operation of a (Westinghouse) single-acting engine in that the bearings may be loose and the machine still operate quietly.

As to throwing the governor out of adjustment or impairing its sensitiveness, it does not follow at all, and there is no reason why it should, because every active function is performed just the same. There is no risk whatever in gradually increasing the tension of one spring and slacking the other, to maintain the same speed, until the point of best operation is reached, and it requires no higher degree of skill than the successful adjustment of other parts of an engine.

This brings up a question that has often ocurred to me and no doubt to others; namely, How is one to know for sure that the tension on each spring is just equal to the centrifugal force acting on the weight, when there are so many unknown elements entering in? Attest the foregoing, see the lengthy and withal good instructions for adjusting shaft governors, means of ascertaining the weight and centrifugal force of the parts, etc., but if the author is candid or honest enough there will perhaps be appended a footnote somewhat as follows: "Owing, however, to several disturbing influences, a correction must be applied to this theoretical total. Experience shows that adjustment cannot be perfect until the engine is started and the shop adjustment changed to suit conditions, etc."

Personally, I do not share Mr. Hudson's apparent opinion of operating engineers as a class; that they must not attempt to adjust a governor but allow the adjustment made by someone else to stand, right or wrong. Why not apply the suggestion in his letter and endeavor to help them to think independently and accurately for themselves?

J. LEWIS.

New York, N. Y.

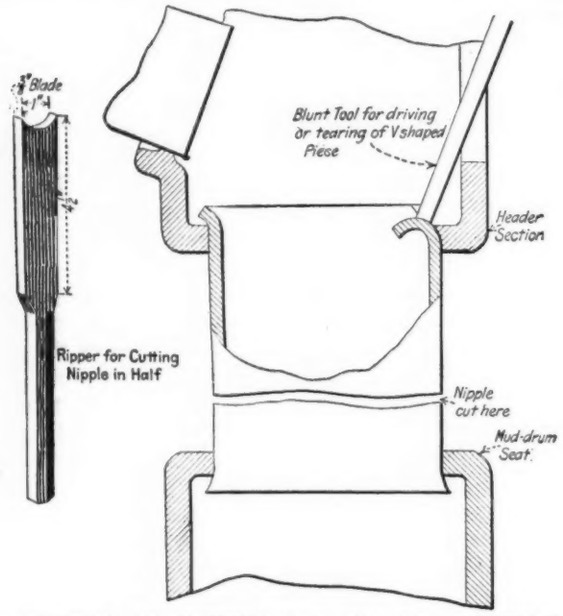
Replacing Nipples in Water-tube Boilers

The short nipples connecting the lower ends of the rear headers to the mud drum in the B. & W. type boilers require considerable attention, as leaks are quite frequent as a result of the rapid exterior corrosion of the nipples from the action of acids contained in soot which accumulates in this part of the boiler. (These acids are generally inactive until they come in contact with water.) All leaky nipples should be rerolled or replaced as soon as the leak is discovered.

Considerable difficulty is often experienced when an attempt is made to remove a defective nipple, and much time and labor are uselessly expended trying to batter or crush the nipple, but if the following method is employed, it is not difficult for one man to remove a nipple in less than an hour. First take off the two lower header caps and remove the mud-drum plates, then with a long narrow ripper (shown in the illustration) cut the nipple in half, working the ripper (which has

a curved end) around the girth of the nipple in the space between the header and mud drum. Next, with an ordinary chisel bar, through the lower header hole cut a vertical slot entirely through the part of the nipple that extends above and below the header seat, and partly through the portion directly over the seat, being careful not to cut entirely through, as seat is easily ruined. Then cut another slot, starting about an inch from the first and cutting at an angle so that the two will intersect below the seat, cutting a small V-shaped piece out of the nipple except for the small portion over the seat which is not cut entirely through; bend the top of the V-shaped piece inward, using a hook-ended bar, and drive it downward with a blunt tool. This will tear off the small sections over the seat, and a few blows will crumple the remainder so as to permit its removal. The process is repeated on the lower half, in the mud drum.

It is important that the new nipples be the proper length; that is, they should extend $\frac{3}{4}$ in. below the lower edge of the mud-drum seat and $\frac{1}{2}$ to $\frac{5}{8}$ in. above the top of the header seat. To cut the nipple to length, never use the ordinary pipe cutters; the work should be


Blade
Blunt Tool for driving or tearing of V shaped Piese
Header Section
Ripper for Cutting Nipple in Half
Nipple cut here
Mud-drum Seat

PROCESS OF CUTTING OUT MUD-DRUM NIPPLE

done in a lathe. If that is not possible, use a hacksaw that does not leave a burr. Before proceeding, all scale or dirt should be cleaned from the header to prevent its being rolled into the joint. Put the nipple into place, blocking it substantially in position from the inside of the mud drum. If the nipple is found to be loose in the seats, shims should be fitted, but if no regular shim stock is at hand, ordinary stovepipe iron is a good substitute. Shims should be fitted carefully, especially the joints, so as not to cause a hump or uneven spot; the ends should be lapped $\frac{1}{2}$ in. and filed to the same thickness as the remainder of the shim. If a small amount of powdered graphite is placed around the top of the seat, it will work into the joint and help materially in filling any unevenness in the face of the seat or nipple, thus promoting a tight joint.

To expand the nipple, the expander should be fitted with the straight rollers, which should be centered over the seat, and using the single-jointed mandrel, the expander is turned until the nipple is rolled tight. Then the straight rollers are removed and the tapered ones substituted, placing the large ends upward and fitting the expander so as to allow the top of the rollers to extend a short distance, say $\frac{3}{16}$ to $\frac{1}{4}$ in. above the top of the nipple, when the rolling operation is repeated, resulting in flaring, or belling, the nipple. The bell should be at least $\frac{1}{8}$ in.; that is, the top diameter of the nipple is increased $\frac{1}{4}$ in. The belling is very important, as it is depended upon to support the end stress, which is proportional to the area of the nipple multiplied by the boiler pressure. After the upper end is rolled, the blocking may be removed from the mud drum and the lower end of the nipple expanded and belled as in the header, except that the double-jointed mandrel is used and the large ends of the tapered rollers are placed downward and extended $\frac{1}{4}$ in. past the lower end of the nipple in order that it may be given a flare also. It sometimes happens that the expander is too short to enable the rollers to extend to their proper position and an attempt to bell will result in the lower end of the nipple being crimped inward. A better job would result if one of the rollers was replaced with a headed one and the expander located so as to bead the nipple just below the seat.

After putting in a new nipple, the boiler should always be subjected to a hydrostatic test and the expanding operation repeated if a leak is found.

Del Monte, Calif. A. C. McHUGH.

Improvised Feed-Water Heater

About two years ago I made a closed heater out of some old 8-in. cast-iron pipe for a casing, with 40 ft. of 1-in. feed pipe inside. I was at a loss for stuffing-boxes to put in the end flanges to make a tight joint around the 1-in. pipe, so I drilled and tapped the flanges for $1\frac{1}{4}$-in. pipe and screwed a short nipple in each. For gland nuts I used pipe caps bored out to slide over the 1-in. pipe and screwed them on the nipples. With a few turns of asbestos wick or cord for packing, the job was complete, and in more than two years' use there has been no trouble or leakage.

The saving in fuel in that time by the use of hot feed water has been quite an item.

San Luis Obispo, Calif. A. F. LINDBERG.

Broken Governor Repaired

Following is a short account of a curious accident and the repairs made to a Buckeye engine governor. The engine is $18\frac{3}{4}$ x 30 in. with a piston valve, operating noncondensing to drive the polishing rolls in a sheet mill at 112 r.p.m. It is fitted with a regular shaft governor and has been in operation for about 20 years.

When I started up a few mornings ago after the usual inspection, it ran all right for about five minutes, then began to act in a very erratic manner. I shut down and found the two lugs on the opposite sides of the eccentric, to which the rods connect that transmit the motion of the weighted arms to the eccentric, had broken. The lugs were $\frac{3}{8}$ in. thick at the point of fracture, but there was no sign of their having received a blow of any kind

and nothing had become caught in the governor, so we are at a loss to know what caused them to break.

The company that built this engine does not always keep repair parts on hand, so it was decided to weld the lugs on again with our oxyacetylene outfit and build up at the point of fracture. After doing this a light lathe cut was taken to get rid of the surplus metal from the weld. The engine has been in operation since, and the job is entirely satisfactory. JOHN F. CURREN.

East Liverpool, Ohio.

Breaking in the New Man

One of the disagreeable tasks that come up in the business of engineering is the breaking in of a new man. To the man himself it is a humiliating time, as no matter how broad his experience, he is sure to pull off some stunt that he well knows will go down in the history of the plant as "boneheadedness." As a general thing the time allowed for breaking a man in is short, and he has to grasp a hundred and one operating details that later will all seem simple, but at first seem very complicated. To the man on the job it is a time for considerable patience, a time when he must stand ready to do a lot of explaining and considerable watching, for he will of course be held responsible for the blunders of the man breaking in. All in all, it is a disagreeable time for everybody concerned, but it helps things when the older men on the job keep in mind the fact that they may be getting broken in on some new job almost any time.

OPERATING CHART

CHANGING FROM TURBINE A TO ENGINE B

Start B jet condenser. Close drips and see that oil is feeding. Hook up steam valve on engine, and open exhaust valve, and bypass steam into receiver. Raise pressure on receiver gage to about 5 lb., then close bypass valve. Hook up exhaust, and start engine slowly. When thoroughly warmed up, bring up to speed, but keep running on throttle.

AT SWITCHBOARD

Close field switch. Equalize voltage. Put in synchronizing plugs, *X* on outgoing machine panel. Phase in, that is, close main switch of incoming machine when hand of synchronism indicator is on mark between slow and fast. Open throttle valve. Slow down turbine, with speed control from board. Turn rheostat on engine panel out, keeping exciter voltage about 110 volts. When turbine meter reads 0, pull turbine switch and open turbine field circuit.

STOP TURBINE AND PUMPS

Trip turbine out. Close throttle. Close steam seals. Shut down air pump, hotwell pump and circulating pump. Open drips on turbine, air pump, hotwell pump and circulating pump. Close water-jacket valve on air pump. Close water seals on hotwell and circulating pump. When turbine stops, shut off water from bearings. Leave turbine and all pumps ready to start in a hurry.

NOTES

Main bearing on high-pressure side has a tendency to run warm. Jet pump *B* will stop, if running too slow and steam pressure drops. A receiver pressure of 5 lb. will give the quietest running condition.

Occasionally one finds instructions posted which help the new man along, especially when they apply to the operating details of the plant, but finding such rules is the exception rather than the rule, although I cannot understand why this should be. A good, clearly written explanation of operating details that can be referred to at any time saves asking questions and eliminates that old excuse, "Why didn't you say you wanted it done that way?" As a matter of fact it will be found that such rules have a value as a constant reference chart even after a man is well accustomed to his job.

The sample chart is one used in changing from a turbine to an engine, both connected to alternators, in which each operation is given in detail so that anyone can study the whole operation at his leisure; and it will be found that a series of such operating charts will tend to systemize the work and will more than repay the trouble of making them and bring the new man to his best efficiency in the shortest time.

South Quincy, Mass. A. D. PALMER.

Putting in Large Gaskets Without Help

In the issue of July 3, page 24, Mr. Chapman gives his method of handling large gaskets. My way is to thinly coat one side of the gasket with shellac and paste it smoothly in place, and in two minutes it will be firmly set and there is no further bother with it.

It might be considerable trouble to get the wooden pins out of a joint going together with capscrews. There is also a chance of a slip or side motion breaking the pins and getting the packing out of place, while with the shellacked gasket it is there to stay and when the joint is together it is ready to bolt up. L. JOHNSON.

Exeter, N. H.

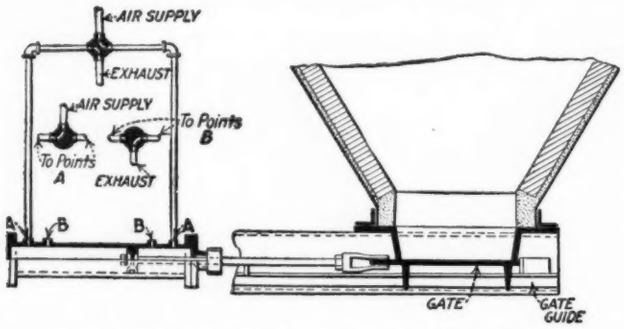
Air-Operated Ash and Coal Gates

In power plants the meanest and most disagreeable work is that of removing ashes from the furnace ashpit to the dump. One operation that is sometimes difficult is the opening and closing of the ash gates. One large Eastern power plant operates its ash and coal gates with compressed air as the working medium. The general design and arrangement of the method is shown in the illustration.

The operation is simple. All that is necessary for the ash men to do is to run the ash car under the hopper and then operate a four-way cock, placed at any convenient point, through an angle of 90 deg., and the gates will open. To close the gates, reverse the operation.

The cycle of the air in the cylinder is easily traced. Additional bosses *B* are supplied on the cylinder in order that the piston travel may be regulated. That

is, if it were found that the air pressure was such that the gates would slam open and shut, it was intended to provide separate pipes for both supply and exhaust, making the end pipes the supply and the inner ones the exhaust and thereby forming an air



AIR-OPERATED COAL- OR ASH-HOPPER GATE

cushion for the piston to bump against. For smooth operation and to obviate the need of regulation on the part of the operator, a valve is installed in the exhaust pipe. This valve regulates the operating speed of the cylinders.

The clearance required for this system below the bottom of the hopper is only 10 in. for gates 36 in. square, and since there are no parts operating in a downward direction, the clearance between the gate and the top of the ash car need be only a few inches.

New York City. W. F. SCHAPHORST.

Ammeter Needle Bent

If the connected load of a squirrel-cage induction motor is not excessive and the voltage impressed on the compensator is normal, the motor will acquire almost synchronous speed on the "starting" side of the compensator in a few seconds, and there will be no abnormal rush of current on throwing the compensator handle to the "running" position. If, however, the connected load is excessive or if the voltage that the compensator applies to the motor is low, owing to excessive losses or to too low a tap of the compensator being used, then the motor will be slow in starting. This will cause the difference between the synchronous speed and the maximum speed, which the motor attains on the "starting" side of the compensator, to be so great that the throwing of the compensator to the "running" side, practically reproduces starting conditions; the current rush will be excessive and may blow the fuses.

The slow starting condition sometimes is relieved by connecting the motor to a higher tap of the compensator. In any event, under proper conditions the current rush on the starting side of the compensator will be greater than it should be on the running side. Ordinarily, the individual fuses or individual breakers are not affected by the starting current, because they are connected on the running side of the compensator. The same is true of ammeters; but if for any reason an abnormal current rush obtains when the compensator is thrown over to the running position, ammeters that are sensitive enough to be accurate are easily injured.

An operator complained of the bending and the breaking of the needles of ammeters used for indicating the running current of a number of three-phase induction motors. As the same type of meter had successfully withstood apparently more severe service in other places, the reason of the breakages did not become evident until the operating conditions were investigated. It was then determined that the cause of all of the trouble lay in the manner in which the motors were started by the operators. The operators were not giving the motors a chance to respond fully to the synchronizing forces on the starting side of the compensator; they were throwing the compensator to running position long before the speed had acquired the greatest value that could be acquired on the starting side. The result was, that every time a compensator was thrown over, there was a current rush that caused the ammeter needle to slam against the maximum stop; after much abuse of this kind, the needle would break.

It would have been practicable to use less sensitive instruments or to have used instruments of greater capacity, but neither of these measures would have been conducive to accuracy. Of course much of the trouble was eliminated by drilling the operators to start properly, but as a factor of safety a short-circuiting switch was installed with each ammeter and this switch was opened only when it was desired to take a current reading. E. C. PARHAM.

Brooklyn, N. Y.

[It is the consensus of opinion among practical electricians that in starting an induction motor, if it can be brought up to approximately synchronous speed before connecting to the high voltage taps, heavy current inrushes cannot be obtained. However, this is not true as will be seen by reading the article, "Transient Conditions in Induction Motors," published elsewhere in this issue.—Editor.]

Fitting in Slide Valve in a Hurry

About two years ago I was called out to overhaul a direct-acting steam pump used to handle crude oil and had only a few hours in which to do the work. After repacking and refitting the valves on the "water end," I found the steam valves and seats badly scored and cut in deep grooves. The time available would not permit of the usual scraper method of fitting, so I filed the seat down true with a large mill-cut file, using a 12-in. straight-edge as a guide, then drawfiled it in the direction of the valve travel with a smooth file. I then trued the valves in the same way except that the drawfiling was across the face—opposite to that of the seats. A test with steam showed the valves to be reasonably tight, and on inspection a month or so later I found the valves and seats in as good condition as if fitted by scraping.

Since then I have used this method many times with good results. The main point is that after being made true, the two parts are drawfiled crosswise to each other, so they wear down smooth. JOHN F. REGAN.

Delhi, N. Y.

When the connecting pipes of a water column are required to pass through a portion of the setting wall, as with the flush-front type of setting for horizontal-tubular boilers, there should be ample clearance space left around these pipes, so that no strain can be placed on them by the settling of the walls or the expansion of the boiler under operation.

Inquiries of General Interest

Relative Steam Economy of Single and of Duplex Pumps—Why is a single direct-acting steam pump more economical of steam than a duplex pump of the same capacity? B. D. A.

The smaller steam cylinders of the duplex pump would have larger percentage of clearance spaces and therefore could not be as economical in use of steam.

Pitch of Girth-Seam Rivets—Why is the pitch on girth-seam rivets generally made smaller than on the longitudinal seams of horizontal return-tubular boilers? R. G.

The outer plates in the girth seams where exposed to the fire are more or less overheated, and there is a tendency of the outer plate to expand away from the inner one and cause leakage. It is therefore desirable to leave less stock between the rivets of the girth seam than on the longitudinal seams as the latter are away from the fire and where, for tightness of the joint, the rivets only need to be close enough together to afford a good calking pitch.

Mercury Column for Standpipe Altitude Gage—What would need to be the height of an open-end mercury column for indicating 85 ft. height of water in a standpipe above the level of a mercury pot placed inside of the standpipe? G. B.

The pressure due to a height of 85 ft. of water would be $85 \times 0.433 = 36.8$ lb. per sq.in. Mercury at ordinary temperatures weighs about 0.491 lb. per cu.in., and to balance a pressure of 36.8 lb. per sq.in. would require a mercury column $36.8 \div 0.491 = 74.9$ in. high above the surface of the mercury in the pot.

Length Boiler Is Increased from Expansion by Heat—How much will a steel boiler 18 ft. long increase in length for an increase of its temperature from 60 deg. F. to the temperature of steam at 100 lb. gage pressure? J. W. M.

The coefficient of lineal expansion of steel is about 0.0000068 per degree F. increase of temperature. The temperature of steam at 100 lb. gage, or 115 lb. absolute, is 338.1 deg. F.; so that the rise of temperature would be $338.1 - 60 = 278.1$ deg. F., and for 18 ft., or 216 in., the increase of length from expansion due to the increase of temperature would be $216 \times 278.1 \times 0.0000068 = 0.408$, or about $\frac{3}{8}$ of an inch.

Friction Between Plates of Riveted Joints—In estimating the strength of riveted joints, why is not allowance made for the increase of strength of the joint from friction between the plates due to setting up and shrinkage of the rivets? W. C. M.

The amount of friction between the plates cannot be depended upon as a holding power because of uncertainty of the condition of the plate surfaces and doubt as to the pressure with which the plates are held together. The joints are known to slip while in use, and in all tests of joints, slippage has occurred at loads that were but a fraction of the ultimate strength. Therefore in computations of riveted joints, assistance rendered by friction between the plates is neglected.

Results of Failure of Corliss Governor Belt—With a Corliss engine having a belt-driven governor, what happens if the governor belt breaks or runs off the pulleys? W. F.

Ordinary Corliss engine governors are so arranged that if the governor drive fails and the governor is not hindered from falling, it will drop to a low enough position to prevent the valve gear from opening the steam valves and the engine will come to rest. If, however, the starting pin or collar, used for holding the governor in position for starting the engine, has not previously been removed, the steam valves will be picked up by the valve gear with admission of more steam than necessary to maintain the proper speed and the engine will run away.

Boiler Horsepower Capacity of Stack—What would be the boiler horsepower capacity of a steel stack 52 in. in diameter and 125 ft. high? G. M.

For ordinary locations and atmospheric conditions the number of boiler horsepower for which a chimney is appropriate with natural draft and providing for a consumption of 5 lb. of coal per horsepower per hour is given by the formula,

$$Hp. = 3.33(A - 0.6\sqrt{A}) \times \sqrt{H}$$

in which A = the cross-sectional area of the smallest part of the flue in square feet and H = the height of the chimney in feet. The diameter 52 in. would be equivalent to a cross-sectional area of $52 \times 52 \times 0.7854 \div 144 = 14.75$ sq.ft. and the chimney would be suitable for $3.33\ (14.75 - 0.6\sqrt{14.75}) \times \sqrt{125} = 463$ boiler horsepower.

Back Pressure Due to Atmosphere and to 20 In. Vacuum—What is the absolute back pressure against the exhaust of an engine when it is discharged into the open air and when discharged into a condenser that maintains 20 in. vacuum? F. S.

When the exhaust is discharged into the open air, the back pressure is the pressure of the atmosphere which, at sea level, is generally assumed to be 14.7 lb. per sq.in. absolute and is about 0.00056 lb. per sq.in. less per foot of elevation of the place above sea level.

"Inches vacuum" signifies absolute pressure of the atmosphere less the pressure per square inch that would be equivalent to the pressure exerted by the same number of inches of mercury column. One cubic inch of mercury at ordinary temperatures weighs about 0.491 lb., hence when discharging against 20 in. vacuum, the exhaust would be discharged against a back pressure of $14.7 - (20 \times 0.491) = 4.88$ lb. per sq.in. absolute.

Use of Machine Oil in Boiler—Would there be any objection to the use of machine oil in a horizontal return-tubular boiler as a protection against rust? The oil referred to is sometimes called lard oil. B. B. T.

Lard oils generally contain acids that are injurious in causing corrosion of a boiler, and where the feed is sufficiently alkaline, the introduction of lard oil will result in severe foaming. The introduction of mineral oil, from distillation of the lighter oils, finally leaves a heavy, gum-like, carbonaceous deposit on the heating surfaces, which will tend to cause burning out of the affected parts. For coating the surfaces with oil for protection against rust while a boiler is laid up out of use, fill the boiler nearly full of water and, when nearly cold, introduce pure mineral oil, using about a gallon of oil to 100 boiler hp. capacity. Then obtain an oil coating of the surfaces by drawing off the water. Before using the boiler for generation of steam, all traces of the oil should be removed by filling the boiler with water; then, after adding 15 to 20 lb. of soda ash per 100 hp., hold a slow fire for about 10 hours, drain off the boiler and thoroughly wash it out with clean water.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Transient Conditions in Induction Motors*

BY R. E. HELLMUND

The letter, "Ammeter Needle Bent," published on page 266, sets forth an idea that is current among many operating men in reference to starting an induction motor, namely, that if the motor is brought up to near synchronous speed on the low-voltage taps of the compensator, and then disconnected and connected to line voltage, no heavy starting currents will result. However, this is not always true, and in publishing this abstract from a paper presented at the midwinter convention of the American Institute of Electrical Engineers, Feb. 16, 1917, it is the purpose to show that a number of conditions may exist that will cause heavy peak currents, when transferring from the low-voltage to full-voltage connections.

IT IS generally understood that the strong demagnetizing or damping effect of a short-circuited low-resistance secondary of an induction motor plays an important part during starting from standstill, in so far as it counteracts and weakens the useful field of the motor to a considerable extent, resulting in very large starting currents, accompanied by relatively small starting torques. It is, however, not always fully realized that the same damping effect influences the motor's working conditions in a number of other ways, leading at times to very unfavorable effects, while serving to good advantage in other cases.

The fundamental fact to be considered in this connection is that any short-circuited low-resistance winding will strongly oppose any change of flux interlinking with the winding. If the interlinking flux is of zero value, the building up of flux will be strongly opposed; on the other hand, if a certain flux happens to exist, its disappearance will be strongly opposed. This is due to the fact that any change of flux, regardless of its cause or nature, will at once induce a voltage in the short-circuited winding, which in turn causes currents to flow. These currents are of demagnetizing direction if a flux is trying to build up or increase, and of a magnetizing direction if a flux is trying to disappear or decrease. This simple phenomenon should be kept in mind in connection with the design of the control with regard to every manipulation.

Considering, for instance, the most common method of starting induction motors by connecting the motor, first to a low-voltage tap of an auto-transformer, subsequently disconnecting the motor and connecting it to the full line voltage. It is frequently assumed that the largest current surge is obtained with this method of starting when the motor is standing still and first connected to the low-voltage tap of the auto-transformer, and that the current obtained when changing over to the full voltage corresponds to the current value indicated by the speed-current curve of the motor for full voltage. As a matter of fact, it is possible to obtain change over currents far in excess of the original starting current.

Various conditions may exist in the motor after a temporary interruption of power supply. When the full-voltage starting contacts are opened, the rotating field set up in the rotor will be prevented from immediately disappearing, by the previously mentioned damping effect of the rotor. The flux will continue to exist and rotate with the rotor for a certain period until the stored magnetic energy is used up by the ohmic losses in the rotor and eddy current.

Since the rotating flux continues to exist it will, of course, continue to induce a voltage in the primary winding. The oscillogram, Figs. 1A and 1B, shows the motor voltage before

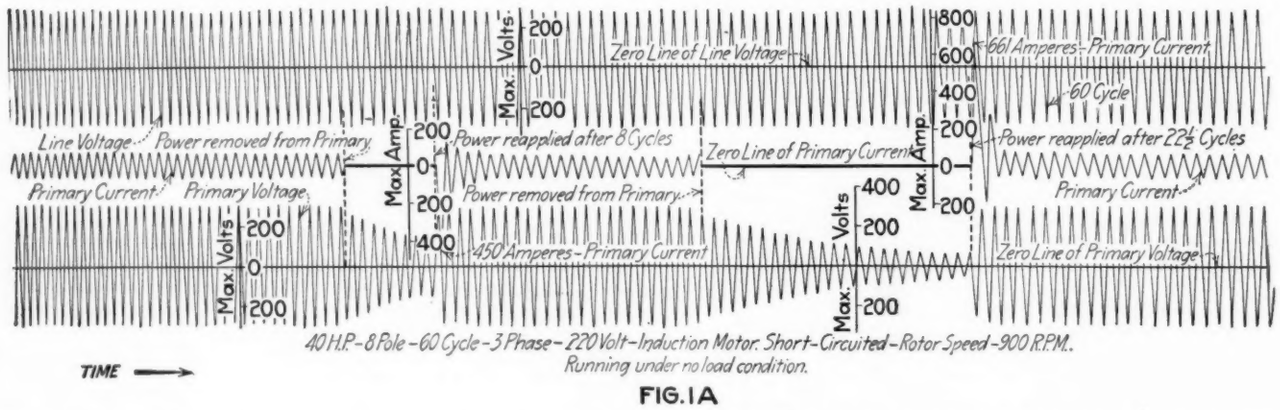


FIG. 1A

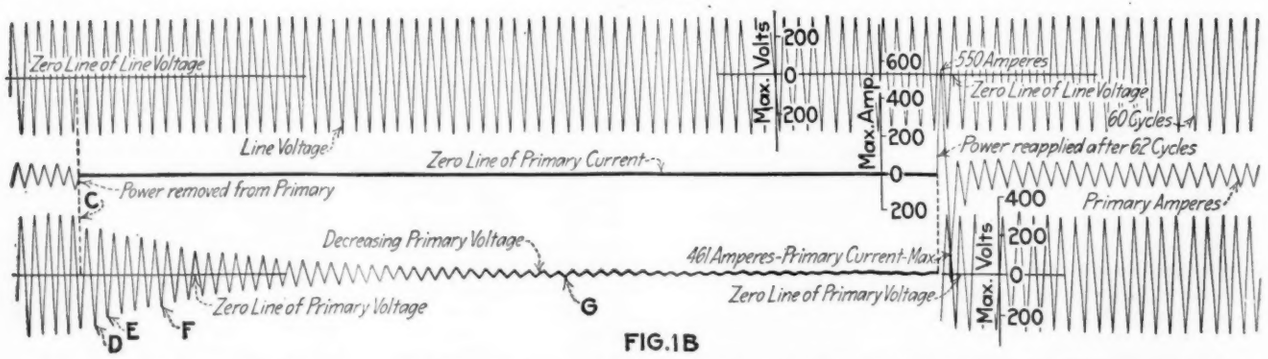


FIG. 1B

FIGS. 1A AND 1B. OSCILLOGRAM TAKEN FROM A 40-HP. INDUCTION MOTOR WITH SHORT-CIRCUITED ROTOR

*Abstract from a paper presented before the American Institute of Electrical Engineers Feb. 16, 1917.

and after the interruption of the primary contacts and demonstrates this point. Fig. 1B is a continuation of the oscillogram shown in Fig. 1A. All the figures have been traced from oscillograms in order to show them more clearly than is possible with the oscillograms themselves. The size of the voltage maintained after interruption and the time during which appreciable voltage is maintained, depend principally upon the amount of magnetic energy stored in the rotor at the time of interruption, as well as upon the rapidity with which the energy is used up by the losses in the motor. The losses depend largely upon the resistance of the secondary, and therefore the energy will be dissipated quicker the higher the secondary resistance. The oscillogram, Figs. 1A and B was taken on a 40-hp. 8-pole 60-cycle wound-secondary motor with the rotor short-circuited. At point *C*, Fig. 1B, the primary circuit is opened, after 1-cycle, or at point *D*, the voltage drops to about 80 per cent., to 75 per cent. after 2 cycles, at *E*, and to 50 per cent. after 6 cycles, or point *F*, and practically dies out after 35 cycles, at point *G*, or 0.6 second.

Maintaining Flux and Voltage

In general, the flux and voltage will be maintained the longer the larger the machine and the smaller the number of poles. This general conclusion is borne out by results obtained in practice. It was observed, for instance, that a 1500-hp. 25-cycle 4-pole induction machine would maintain a sufficient voltage to keep incandescent lamps luminous for 7 sec. after the current supply was interrupted. On the other hand, a 5-hp. 10-pole 60-cycle motor maintained a voltage for only a comparatively short period, the voltage following the current interruption being 25 per cent. after 0.1 second.

It is evident from the previous considerations, that if the primary switches are closed after a temporary circuit interruption the voltage and flux conditions of the motor

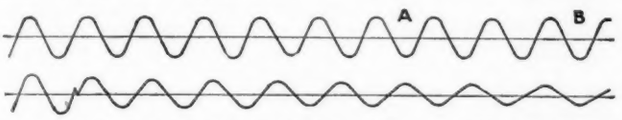


FIG. 2. OSCILLOGRAM SHOWING HOW STATOR VOLTAGE DROPS OUT OF STEP WITH THAT OF THE LINE

may be slightly different under various assumptions of motor characteristics, load, time elapsed, etc.

Considering first the case where the time of change-over from the low-voltage tap to full voltage is long enough to permit the rotor flux to reach zero value before the full-voltage contacts are closed. It is evident from the fundamental facts stated in the beginning of the paper, that upon closing the contacts, the damping effect of the rotor will prevent the quick establishment of the rotor flux, on account of the rotor current strongly opposing the effect of the primary current. This will also prevent all but the leakage part of the primary flux from building up quickly, so that at the first instance whatever counter-electromotive force exists, has to be largely supplied by leakage fluxes, no matter what the speed of the motor may be. The proper counter-em.f. must always be approximately equal and opposite to the impressed electromotive force after the circuit is closed if the current is not to exceed normal value. The amplitude of the current peaks when connecting the motor to the line with no flux in the secondary may, therefore, be the same near synchronous speed as it is at standstill for a given motor voltage.

Since with the standard method of starting, the voltage after the change-over is usually larger than when starting from standstill, it is evident that the current peak after the change-over may be larger than when starting, assuming in both cases that the rotor field is zero at the time the connection is made. This does not necessarily mean that the effect upon the line and control apparatus at the time of the change-over is worse than at starting. In either case the current settles down within a short time to normal value. In general, as already pointed out, it will be found that the size of the current peaks relative to the sustained current value is liable to be the larger, the larger the machine and the smaller the number of poles.

Fig. 3 shows a current peak of 778 amp. obtained with the 40-hp. 8-pole motor, which has a sustained standstill current of only about 425 amp. effective (600 amp. peak value) and about 115 amp. effective (163 amp. peak value) sustained current at the speed at which the test was made. These conditions were obtained with an external resistance in the rotor, and it is evident that worse conditions may be experienced with the rotor short-circuited.

Considering now a case in which the change-over or current interruption is accomplished very quickly so that the contacts are reclosed before the rotor field has died out. Then also assume at present that in such a case the load of the motor happens to be light, so that the rotor rotates at practically synchronous speed and that the rotor inertia is large enough so as to keep the motor speed practically unchanged during the power interruption. With these assumptions, the counter-electromotive force of the stator induced by the flux rotating with the rotor will maintain a synchronous relation with the line em.f. and if the contacts are reclosed, the counter-em.f. at a certain amount and proper phase relation already exists, keeping the initial current rush down to a very small value. In such cases it may be that the initial current closely agrees with the current value as given by the speed-current curve of the motor.

Induced Voltage Out of Synchronism

If, on the other hand, the motor is heavily loaded, so that its rotor speed is appreciably below synchronous, and if the rotor has small inertia, so as to permit a further drop in speed during the current interruption, the voltage induced by the flux rotating with the rotor speed will fall quickly out of synchronism with the line voltage. Such a condition is demonstrated in Fig. 2, which has been traced from an oscillogram, which was unfortunately taken with the voltage element connected in opposite directions.

If we assume, for instance, that the stator voltage has slipped one-half cycle relative to the line voltage, as at point *A*, when the contacts are closed, we have a condition very much the same as obtained in a synchronous machine connected to the line when out of synchronism, and it is evident that very large currents may flow temporarily because it is not only necessary to build up a rotor flux against the damping effect of the secondary winding, but it is necessary to first reduce the existing flux to zero and build up the flux in the opposite direction. It is considered poor practice to connect large synchronous motors to the line before establishing synchronism, and equivalent precaution should be taken when starting large induction motors to prevent severe burning and arcing.

The author was not fortunate enough to get an oscillogram showing the closing of the circuit at the most unfavorable point. This is pretty hard to do in view of the fact that very small fractions of a second bring about important differences in the conditions. If the circuits were closed, for instance, at point *B* in Fig. 2—that is, only 0.12 sec. later—the voltages are again in phase and fairly favorable current conditions would obtain.

High Current Peaks

Figs. 4 and 5 were taken with the same motor as Fig. 3 and show the highest current peaks tested, giving about 1300 amp. (estimated) and 806 amp. respectively, as compared with a sustained standstill current of 450 amp. effective (635 amp. peak value), and a sustaining value of 150 amp. effective (212 amp. peak value) for the speed at which the test was made.

The previously discussed current-peak values are affected by the damping current in the rotor and should not be confused with the transient current peaks obtained when connecting any inductive piece of apparatus to an alternating voltage, even when the secondary is open-circuited and there are no damping effects. In this connection it might be mentioned that motors with open, external secondary circuit should not always be considered as entirely free from damping effects. A delta-connected secondary, for instance, may develop appreciable transient damping currents under certain conditions, even with open secondary-control switches, especially when temporarily only one of

the primary circuits of a polyphase motor is closed, as is frequently the case on account of the fact that the switches do not all come in simultaneously.

In this paper the author also discusses the effects of secondary damping circuits upon operation and design; over-voltages with closed-circuit secondaries; and over-voltages with over-synchronous speed, as in changes from high to low speed in a two-speed machine. Over-voltages up to at least four times normal, it is pointed out, may be obtained with open-circuited secondary, causing insulation breakdown in the motor and control.

In conclusion, it is pointed out that other cases where transient conditions of induction machines are of practical importance with regard to the design of the control arrangement might be cited. While practical experience has taught both control and motor designers, relatively early, to take care of most of the conditions pointed out in this paper, it is believed that more detailed study of the conditions to be met will lead to further improvements.

The induction motor enjoys the just reputation of being the simplest motor requiring the least attention and maintenance of any of the existing types of motor, and there is no doubt but that this reputation can only be improved if all characteristics of the motor are more fully understood and always properly taken care of by a harmonious combination of motor and control design.

Municipally Owned Plant Makes Good Showing

According to the auditor's report published in a local paper, the financial condition of the Jacksonville, Florida, municipal electric plant is highly satisfactory, the physical condition or upkeep of the best and the rates for service to customers low. The plant has been in operation since 1895, when a $75,000 bond issue was expended. Since that time, however, there have been other bond issues, and now the plant represents a total investment of about $200,000. The receipts for 1916 were slightly over $610,000 and disbursements for operating, in round numbers, $153,000, as follows: Maintenance, $46,000; general expenses, $40,000; interest, $9600; refunds on customers' deposits, $12,000; showing a profit of $350,000 for the year.

The meter rates for various services and quantities used are: For lighting, 7c. per kw.-hr. for the minimum service, with graded discounts up to 40 per cent. when the monthly bill exceeds $300; for cooking and heating 2c. per kw.-hr.; for power between the hours of 10 p.m. and 5 a.m. 2c. per kw.hr.; and for regular service the rate is graded down from 7c. to 2c. per kw.-hr. as the total power used increases. There are 121 employees in the electric department, and the annual payroll is $115,000.

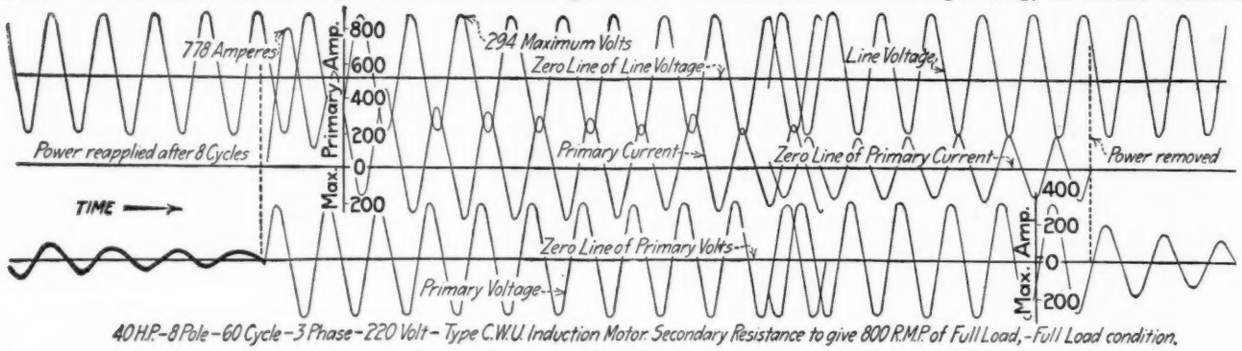


FIG. 3

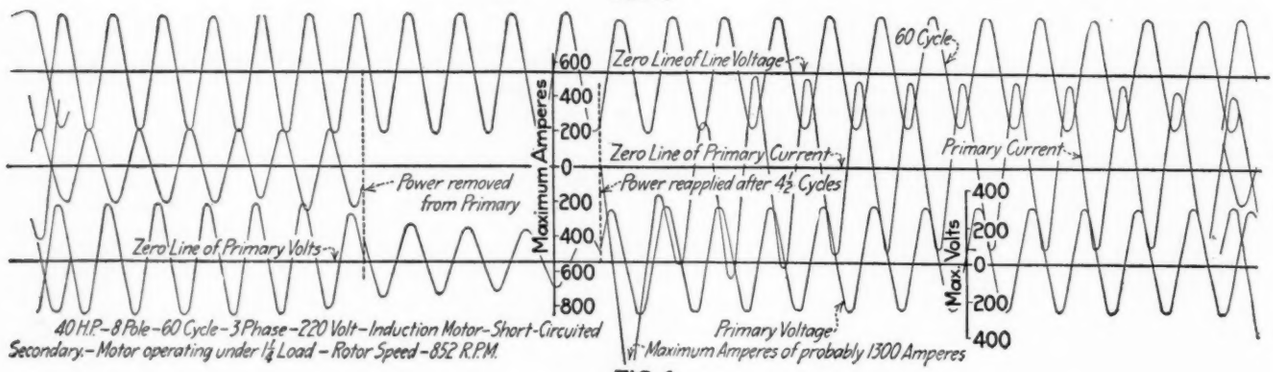


FIG. 4

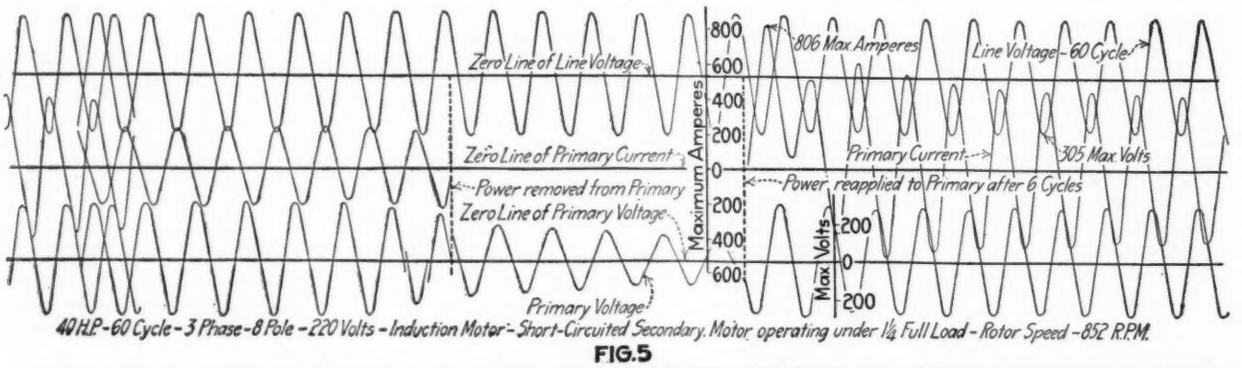


FIG. 5

FIGS. 3 TO 5. SHOW DIFFERENT VALUES OF PEAK CURRENTS OBTAINED ON AN INDUCTION MOTOR WHILE STARTING, WHEN CHANGING OVER FROM LOW- TO HIGH-VOLTAGE TAPS

Excess Hydro-Electric Power Used To Produce Steam

According to the report of the N. E. L. A. Committee on Progress, many hydro-electric plants in Europe have, for some months of the year, an excess of energy that to a large extent is not utilized. The use of this energy for raising steam in the boilers of a reserve steam plant has naturally suggested itself, and experiments along this line have been made, first with two steam boilers, by the electric supply company of Zurich, Switzerland, at its Letten plant.

The electric-heating sets consist of cast-iron resistance elements, insulated with mica and eternit. Each heating unit consists of six resistor sets, which may be connected at will according to the particular conditions. While electric heating is being carried on, the heating chamber is hermetically closed. The maximum temperature of the heating resistors is below 1112 deg. F. The boiler has 1937 sq.ft. of heating surface and contains 4490 gal. of water. With a maximum consumption of 84 to 86 kw., 3784 lb. of steam is produced in 24 hours and the steam is utilized in various ways. The three boilers of the Zurich station, equipped with electric-heating sets, furnish in the whole 12,386 lb. of steam per day with a consumption of 7392 kw.-hr., saving 1654 lb. of coal per day. This is a specific consumption of 0.6 kw.-hr. per lb. of steam.

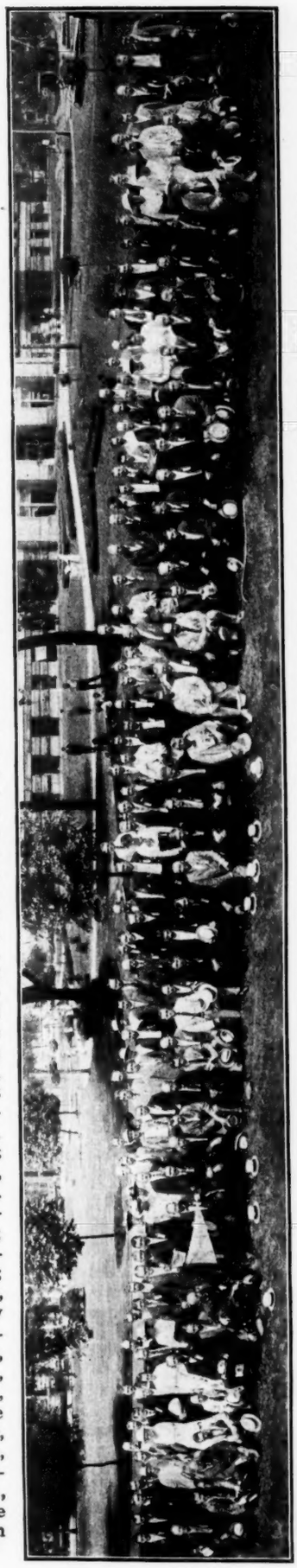
Convention of the Universal Craftsmen Council of Engineers

The Universal Craftsmen Council of Engineers held its fifteenth annual convention at Toledo, Ohio, during the week beginning Aug. 6, with headquarters at the Boody House. The business sessions of the convention were held in the Masonic Temple. There were present upward of 200 delegates. Harmony prevailed throughout the several meetings, and many important resolutions were adopted conducive to the welfare of the organization.

The auditorium of the Terminal Building was nicely arranged and neatly decorated for the use of the supplymen for the display of their wares. There were 91 booths, and many of them were occupied by the leading firms in the engineering-supply field. From an exhibitor's viewpoint, it was unfortunate that the headquarters and the meeting place of the delegates were so far removed from the exhibition hall, as this prevented the engineers visiting the display as frequently as was desired; however, in some respects the arrangements were above the average.

The opening exercises of the convention took place on Monday evening at 8 o'clock, presided over by William J. Biebesheimer, chairman of the local committee. Mayor Charles M. Milroy welcomed the convention to Toledo, and in presenting the key of the city, he opened the door of love and hospitality to its guests. He hoped that all who had the time would visit him at his office. William L. Fetters, worthy chief of Toledo Council No. 7, responded for the engineers. Attorney Charles T. Lawton enlarged upon the manufacturing industries and other business interests of Toledo. He told of the beauties of the city and mentioned the interesting visiting places. He knew that the folks would be so impressed with their call that they would want to come again, and if he could change his words of welcome into flowers, he would "pin on the breast of each lady an American Beauty and on the men a forget-me-not." Grand Worthy Chief Nathan J. Burdick spoke briefly of the aims and objects of the organization. William J. Biebesheimer said that he had used his best judgment in the general arrangements of the convention. He knew he had made mistakes, and if anyone had a grouch, not to tell it to his neighbor, but to come to him and the error would be remedied if possible. The exercises closed with the singing of "America."

On Tuesday evening an enjoyable entertainment was given in the exhibition hall. The Waumee Valley Odd Fellows' Band played several selections. Chairman Biebesheimer then introduced the talent, as follows: Thomas Miller, Templeton Manufacturing Co.; Herbert Wunder, Lunkenheimer Co.; Fred Hickey, Dearborn Chemical Co.; Jack Armour, *Power;* Billy Murray, Jenkins Bros.; Greiner and Kittlewell, courtesy of the chairman. On Wednesday afternoon the company attended a picnic and basket party at Walbridge Park. On Wednesday evening the men-folks held a smoker at the Orpheum Theater at which the supplymen entertained. The same evening the ladies witnessed the vaudeville show at Keith's Theater. At noon on Thursday the annual memorial services were conducted, at the close of which the delegates marched to the monument of the late President McKinley, and after an oration by Past Worthy Chief Robert Ingleson, a wreath was placed thereon. The leading feature of the entertainment was the banquet at Masonic Temple on Thursday evening. Short addresses by many of the past worthy chiefs were followed by an entertainment and dance. During the week instructive and interesting lectures were given in the exhibition hall by Hon. Alton B. Parker, Doctor Hobbs, Dr. C. M. Holmes, Victor F. Noonan and Frederick H. Evans. The following officers were elected and installed by the Grand Council: Nathan J. Burdick, past chief, Oak Park, Ill.; Herbert E. Terry, chief, Toronto, Canada; Frank M. Townsend, assistant chief, Grand Rapids, Mich.; Thomas H. Jones, secretary, Alexander County, Virginia; Frank Conroyd, treasurer, Chicago, Ill.; John Moore, Warden, Buffalo, N. Y.; Andrew Benner, guard, Columbus, Ohio; P. H. Early, chaplain, Milwaukee, Wis.; W. G. Warfield, Newark, N. J., Orville Y. Williams, Louisville, Ky., and H. C. Burton, Cleveland, Ohio, trustees. Detroit, Mich., was selected as the next convention city, in August, 1918.



MEMBERS AND GUESTS AT THE UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS' CONVENTION, TOLEDO, OHIO, AUG. 6 TO 9

Yonkers Wins Smoke-Abatement Suit

The long and bitterly contested suit of the City of Yonkers, N. Y., against the Federal Sugar Refining Co. has finally been decided in favor of the city. In August, 1907, complaint was made of the alleged nuisance maintained by the sugar company burning soft coal, making smoke, cinder and soot. The temporary injunction then granted was later vacated and the matter sent to a referee, who decided against the company. In an appeal the decision was reversed. The city then took an appeal to the Court of Appeals, wherein the lower court was sustained. The company then applied for the appointment of a referee to assess the damages it had incurred by reason of the injunction. The referee rendered an opinion against the city, with damages of $37,778.21. An appeal was again taken by the city, but the appellate division affirmed the report of the referee with the exception that it reduced the amount of the damages. An appeal was again taken by the city and the judgment was reversed, with costs in all courts in favor of the city.

Condensers at Ashley Street Station

Our attention has been drawn to an error in connection with the description of the Ashley Street Station in the July 31 issue, in which the maker of the condensers was given as the C. H. Wheeler Co. This should have been the Wheeler Condenser and Engineering Co., of Carteret, N. J. The condensers are of the admiralty type and the auxiliaries for each include: (1) A circulating pump of the single-runner type, designed for a capacity of 3600 gal. per min. against a 30-ft. head and driven by a 300-hp. geared Kerr turbine. (2) A motor-driven, single-runner condensate pump running at 1800 r.p.m. and discharging against a head of 80 ft. (3) An air pump of the hydraulic type, A. E. G. design, driven by a 100-hp. motor at 1800 revolutions per minute.

Lyon Prepares for Third Sample Fair

The opening day for the third sample fair at Lyon, France, has been designated as Mar. 1, 1918. Already 500 applications for stands have been received, and 1000 new booths have been ordered to take care of the additional exhibitors that are expected. A feature of this fair will be a commercial congress, to be attended by delegates from all the allied countries as well as the neutral nations. Several important questions will be taken up for discussion.

The City of Lyon, through its mayor, who is president of the fair, has invited the United States to make an exhibit. It is hoped (and the mayor has given the suggestion his earnest support) that if the United States erects a building, it may be used after the fair as an American commercial museum. This would be of great benefit to American manufacturers, and it is hoped that the project will meet with their hearty approval.

It is not too early to commence making preparations for this fair. Manufacturers should carefully study the various classes of exhibits and begin now to make arrangements.

The catalog exhibit that was conducted by the American consulate last year under the auspices of the Department of State was such a success as to warrant the earnest recommendation that a larger exhibit be held next year and that manufacturers who have an idea of entering the foreign markets of Europe should have catalogs dispatched. These should preferably be printed in French, although arrangements were made at the last fair to take care of translations. The metric system should be used in such publications where possible, and the issuing of special catalogs in French is recommended and they should be sent promptly.

Although notice was given eight months in advance of the last fair, many manufacturers put off until the last minute the sending of catalogs, with the result that the publications did not arrive in time for display. This proved a great disappointment. It is urged that American manufacturers, generally, send catalogs addressed to the American consul at Lyon and mark them "Catalogs for Lyon Fair." It is impossible, in view of the limited space allotted, to handle large numbers of catalogs, so manufacturers should limit the number sent to five copies.

Provision is made at the fair for 57 classes, a few of which follow:

No. 1. Industrial Furnishings—Industrial alcohols, coal, industrial rubber, oils, gauze, transmission belting and various furnishings.

No. 2. Tools, hardware, sheet iron, cutlery, etc.

No. 3. Heavy Metallurgy and Minerals—Steel, cables, chains, iron, various minerals, small beams and refractory products.

No. 4. General Mechanics—Machines in all makes, presses and pumps, turbines, apparatus for raising, weighing and measuring, heating apparatus, portable engines, locomotives and tractors, mechanical installations, coppersmithing, cork and valve making.

No. 5. Electrical Construction and Materials—Electrical apparatus and lighting, bell hanging and telephony.

No. 6. Industrial Constructions—Metallic framework, cement floors and material for contractors.

Further information concerning the other fifty-odd classes may be obtained from the Department of Commerce.

New Type of Gas Engine

A new type of gas engine recently announced is essentially an internal-combustion engine in which air is compressed and mixed with oil which is atomized and ignited by an electric spark. The resulting intensely hot flame of combustion is brought into contact with small quantities of water which cools the gases to a practical working temperature while generating a desirable amount of steam, which, with the gases of combustion, enters the cylinders.

The following claims are made for the engine: Starting without any previous heating, directly with the oil, by hand or electric cranking or by compressed air. Only one spark plug is used, regardless of the number of cylinders. When the engine is under way, the current is turned off. Ignition outfits are not required, as a battery with coil and spark plug will suffice. No heat is lost through water jackets, and little power is wasted in the low-pressure exhaust. The water used is easily condensed and returned to the tank. There are no objectionable carbon deposits. No data of tests of the engine are yet available.

Cause of Fireman's Death

The Wisconsin Supreme Court has affirmed an award made under the Wisconsin Workmen's Compensation Law for death of a fireman who had been employed in a steam-power plant. His duties consisted in taking clinkers from the combustion chambers of boilers, and cleaning, polishing and oiling the engine and boilers. In the course of this work his thumb became lacerated and infection followed, resulting in his death. The principal controversy involved in the case arose on the point whether disease germs found their way into the unfortunate man's system through the cuts or not, and the court finds that there was sufficient evidence to warrant answering this question in the affirmative. (William Rahr & Sons Co. vs. Industrial Commission, 163 Northwestern Reporter, 169.)

Overroping in a rope transmission certainly retards efficiency. The fault sometimes manifests itself by the slack changing with the pulling side, and at other times by the ropes traveling across the grooves or even leaving the pulleys altogether. When such troubles arise, it is best to remove one or several ropes if need be, without interfering with the splicings. Pass them over both pulleys and tie them well back to avoid revolving shafts. They can then be readily put back to work as the others give out. We have known instances where half the original number were taken off before satisfactory driving was obtained. This state of things frequently arises, even under fairly regular loads, when actual requirements come below the calculated power. A golden rule in rope transmission is that ropes like work to do.—*J. Melville Alisom, Manchester, England.*

Book Review

LOCOMOTIVE VALVES AND VALVE-GEARS. By Jacob H. Yoder and George B. Wharen. D. Van Nostrand Co., New York. Cloth; 6 x 9 in.; 272 pages; 274 illustrations. Price, $3 net.

The object in the preparation of this book, as stated in the preface, is to acquaint railroad shopmen and others interested in the subject with valves and valve-gears as applied to modern locomotives as a preparation to valve setting. The style is of a practical nature, and technical discussions have been to a large extent avoided. It is, therefore, an everyday reference book for the average mechanic employed in railroad shops. It must not be inferred, however, that the work is of an elementary or superficial character, for it is not; furthermore, few books that come to our notice show equal thoroughness and painstaking care in preparation.

Chapter 1 of 34 pages deals with types of valves used on locomotives. In Chapters 2 to 4 inclusive, valve-gears, including the Stephenson, Walschaert, Baker, Southern, Joy, Young, Gooch and Allen, are illustrated, described and analyzed. Chapter 5 takes up the effect of altering valves and their events. Chapter 6 is on valve setting, covering all forms of valves and valve-gears in general use. The final chapter (7) gives a general summary with an appendix dealing with the indicator and its application, horsepower, tractive force and general classification of locomotives.

Application of the information given in this book should make it possible for a good mechanic to understand and properly adjust the valve motion of any type of locomotive.

Personals

W. A. Greaves has sold his interest in the Greaves-Klusman Machine Tool Co., Cincinnati, Ohio.

Harry G. Seltzer has taken a position as assistant sales manager for T. A. Willson & Co., Inc., and will devote his interests to the Willson goggle.

W. H. Ripley, formerly with the Griscom-Russell Co., has been appointed New York sales agent for the Nashua Machine Co., to succeed the late W. E. Van Keuren.

R. B. Dale, formerly chief engineer of the Erie City Iron Works, Erie, Penn., has resigned to accept a position in the planning department of the Franklin Manufacturing Co., Franklin, Penn.

Charles H. Purdy has resigned his position as superintendent of the Dalton Machine Co., New York City, and will design and construct special machinery with offices at 103 East 125th St.

H. L. Shepler, who recently resigned his position as vice president, in charge of production, of the Willys-Overland Co., Toledo, Ohio, will become associated with the Aircraft Production Board in Washington.

M. J. McCormick, formerly manager of the machine-tool department of the Canadian Fairbanks-Morse Co., Montreal, has become associated with the McCormick Machinery Co., Montreal, dealer in machinery and supplies.

John F. Card, for the last eighteen years superintendent and designing engineer of direct-current machinery for Fairbanks, Morse & Co., at Three Rivers, Mich., has resigned to go into the manufacturing business on his own account.

Edward J. Kearney, secretary-treasurer of Kearney & Trecker Co., Milwaukee, maker of millers, has been appointed member of the Wisconsin State Board of Vocational Education, created by the last legislature. He is one of three representatives of the employers of Wisconsin.

Lawrence N. Siler, mechanical and electrical engineer with the J. G. White Management Corporation, New York City, has been assigned to the engineering staff of the Manila Electric Railroad and Light Co., Manila, P. I., which is being operated by the Management Corporation.

J. F. Sees, formerly assistant equipment engineer of the Remington Arms-Union Metallic Cartridge Co., Bridgeport, Conn., has been appointed a captain of ordnance in the Officers' Reserve Corps. He has been called into service at the Frankford arsenal as assistant superintendent of small-arms ammunition.

F. R. Brosius has resigned his position as superintendent of power stations for the Union Gas and Electric Co., of Cincinnati, and has been appointed superintendent of power for the Kimberly-Clark Co., paper manufacturers of Neenah, Wis., with a number of plants and a capacity of about 450 tons per day.

L. G. Henes, formerly Pacific Coast representative for Manning, Maxwell & Moore, has resigned to act as factory representative for Steinle Turret Machine Co., Foster Machine Co., Newton Machine Tool Works, New Britain Machine Co., Houston, Stanwood & Gamble Co. Offices are at 1037 Monadnock Building, San Francisco. .

A. A. Johnson, of Wiona, Mont., has formally taken over the electric-light plant at Terry, Mont., which was owned by the Terry Improvement Co. He will immediately change the plant from a direct- to an alternating-current system. The company will be under the control of A. J. Ensteness, who has had charge of the Wiona Power plant for a number of years.

H. M. Wood has resigned from the Lodge & Shipley Machine Tool Co., Cincinnati, to become associated with the Malm & Wood Machine Co., Dayton, Ohio, which has formerly been known as the Malm Machine Co. Axel Malm is president and mechanical engineer of the new firm, while Mr. Wood acts in the capacity of vice president and general manager. The product of the company is rotary presses and dies.

Prof. Lionel S. Marks, head of the combined departments of mechanical engineering of Harvard University and Massachusetts Institute of Technology, is to assist the National Advisory Committee for Aëronautics. He will be assigned to assist in the special work of the subcommittee on power plants and will have charge of certain investigations relating to airplane-engine design conducted by this committee at the Bureau of Standards.

Engineering Affairs

The Association of Iron and Steel Electrical Engineers will hold its eleventh annual convention at Philadelphia, Penn., Sept. 10-14, with headquarters at the Bellevue-Stratford Hotel.

The American and Canadian Engineers and Architects of Norwegian birth or descent will hold an informal congress and reunion at the Chicago Norske Klub on Sept. 27, 28 and 29.

The Third National Exposition of Chemical Industries will be held at Grand Central Palace, New York City, during the week beginning Sept. 24. The purposes of the exposition are to indicate where progress can be made in all the chemical industries, where opportunities await development, and how our national resources and wastes can be made valuable and useful. Many speakers of prominence will be in attendance.

Trade Catalogs

Automatic Injector. The William Powell Co., Cincinnati, Ohio. Booklet. Pp. 12; 3½ x 6 in.; illustrated.

"Adapti Boxes," Conduit Fittings. The Adapti Co., Cleveland, Ohio. Catalog No. 106. Pp. 64; 6 x 9 in.; illustrated.

A. C. Oil Switches for Reversing Service. Crocker-Wheeler Co., Ampere, N. J. Bulletin 179. Illustrated; 4 pages; 8 x 11 in. Describes a new type of oil switch for reversing two- and three-phase motors.

Solvay Alkali. The Solvay Process Co., Syracuse, N. Y. Treatise dealing with the various forms and uses of alkali and containing chemical and commercial tables which ought to be useful to the consumer. Pp. 56, 7½ x 10 in.; illustrated.

Hoisting Machinery for Industrial Works. Shepard Electric Crane and Hoist Co., Montour Falls, N. Y. Handbook. Pp. 116; illustrated. This contains data describing the various types of hoists and cranes together with tables of dimensions.

Hydroelectric and Steam Power Plants. Vielé, Blackwell & Buck, 49 Wall St., New York. Booklet illustrating some of the engineering and construction work done by above company in various parts of the United States, Canada and Mexico. Pp. 37; 8¼ x 11¼ in.

Oil Burners and Oil-Burning Systems— Hammel Oil Burning Equipment Co., Inc., 409 Pine St., Providence, R. I. Catalog, 1917; pp. 32; 6¾ x 9¾ in.; illustrated. The subject of oil burners and oil-burning systems is thoroughly discussed, which is interesting now that the use of fuel oil instead of coal is becoming popular.

Export Engineering and Contracting— American Steel Export Co., Woolworth Building, New York. Booklet. Pp. 20; 3¾ x 8¾ in.; illustrated. Published in various languages to acquaint the foreign purchasers of mechanical equipment with this company's methods and facilities to meet their requirements; also to call the attention of American manufacturers to facilities for relieving them of the difficult features of export business.

Business Items

The Shepard Electric Crane and Hoist Co., Montour Falls, N. Y., has established an export department at 30 Church St., New York City.

The Chas. A. Schieren Co. has completed the building of a new plant at Bristol, Tenn., built as an addition to its tannery there, at which manufacturing will begin at once.

The General Electric Co. has moved its New York offices from 30 Church St. to the Equitable Building, 120 Broadway, where the entire twentieth floor has been arranged and furnished for this, the largest district office of the company.

The **Willys-Overland Co.,** Toledo, Ohio, has recently taken orders for a large number of airplane motors. Of these motors, 4500 will go to the United States, 4500 to Canada and 1000 to England.

The Heald Machine Co., Worcester, Mass., has opened a branch office in the Commonwealth Building, Philadelphia, Penn. The office will be in charge of S. M. Hershey, formerly connected with the Hyatt Roller Bearing Co. and the Norton Company.

A. D. Rose and **E. C. Powell,** formerly of the Frick Lindsey Co., Pittsburgh, Penn., have founded a new company under the name of the Rose Tool and Supply Co., 5 Wood St., Pittsburgh, Penn. The firm is equipped to supply mine, mill and contractors' supplies.

Charles A. Schieren Co., New York City, will begin manufacturing immediately in the new addition to its tannery at Bristol, Tenn. The capacity of the new plant will be 24,000 lin.ft. of belting per day at the start and will be increased to 50,000 ft. daily when skilled help can be secured.

The National Association of Purchasing Agents will hold its annual congress at Pittsburgh, Penn., Oct. 9-11. The program includes business sessions for the mornings and visits to and inspection of industrial works during the afternoons. Speakers of national prominence will attend the banquet on the evening of the second day.

The Link-Belt Co., with factories in Chicago, Philadelphia and Indianapolis, and sales offices in the principal cities of the country, announces its ability to again furnish Link-Belt mono-rail electric hoists for quick shipment. These machines are made at the Philadelphia plant, where a large additional building is rapidly nearing completion.

Gorham & Goddard Co., 39-45 Congress St., W., Detroit, Mich., recently incorporated to do machine manufacturing and salvaging work, has taken over the entire salvaging business of the Gorham Tool Co. The new company is prepared to do salvaging work on milling cutters, end mills, reamers and drills and to manufacture special tools, jigs, fixtures, punches, dies, gages, cutters, reamers, etc.

Duquesne Electric and Manufacturing Co., of Pittsburgh, Penn., with shops at East Liberty Station, Pittsburgh, Penn., and a branch office at Cleveland, Ohio, in charge of W. L. Moorhead, has been incorporated with a capital stock of $50,000. The company has been operating under the name of Service Supply and Equipment Co. for over a year. The shops are completely equipped for rebuilding electrical machinery and also handle new machinery for immediate delivery. In the future they will manufacture a complete line of switches and switchboards.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Aug. 18, 1917	One Year Ago	Aug. 18, 1917	One Year Ago
Buckwheat	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Aug. 18, 1917	One Year Ago	Aug. 18, 1917	One Year Ago
Clearfields	$4.15—4.50	$1.15—1.75	$8.00—8.35	$4.25—5.00
Cambrias and Somersets	4.40—4.75	1.45—1.90	8.25—8.50	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $5.14—6.50, as compared with $2.85—2.90 a year ago; on cars Boston price is $9.00—9.25.

*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Aug. 18, 1917	One Year Ago	Aug. 18, 1917	One Year Ago
Buckwheat	$4.10—4.75	$2.75	$4.25—5.00	$2.40—2.75
Rice	3.40—3.60	2.25	3.25—3.60	2.10—2.20
Barley	3.00—3.25	1.75	2.25—3.00	1.85—1.95

BITUMINOUS

	F.o.b.	Mine Prices
Bunker coal	$6.00—6.25	$4.00—4.50
Commercial	5.25—6.00*	3.00

*Based on Federal Trade Commission suggestion.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Aug. 18, 1917	One Year Ago	Aug. 18, 1917	One Year Ago
Buckwheat	$2.90	$1.65	$3.80	$2.55
Rice	2.40	1.00	3.40	....
Boiler	2.20	.90	3.30	1.80
Barley	1.90	.75	2.15	....

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Aug. 18, 1917	One Year Ago
Slack	$3.00—3.25	$0.95—1.00
Mine-run	3.00—3.25	1.35—1.45
¾-in.	3.50—3.75	1.45—1.55

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump	$3.25–3.50	$3.25–3.50	$3.75	$3.00–3.25	$3.00–3.25
Lump	3.50	3.50	3.75	3.25–3.50	3.50
Egg	3.50	3.50	3.75	3.25–3.50	3.50
Nut	3.50	3.50	....	3.25–3.50	3.50
No. 1 nut	3.50	3.50	....	3.25–3.50	3.50
No. 2 nut	3.50	3.50	....	3.25–3.50	.....
No. 3 nut	3.25–3.50	3.50	....	3.25–3.50	.....
No. 1 washed	3.50	.....	....	.....	.....
No. 2 washed	3.50	.....	....	.....	.....
Mine-run	2.75	2.75	3.25	2.75	2.75
Screenings	2.75	2.75	....	2.75	2.75

Hocking lump, $3.75; splint lump, $3.75.

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Aug. 18, 1917	One Year Ago	Aug. 18, 1917	One Year Ago	Aug. 18, 1917	One Year Ago
6-in. lump	$3.25	$1.35	$2.25–3.00	$1.35	$2.75	$1.00
2-in. lump	3.00	1.35	2.25–3.00	1.25	2.10	.90
Steam egg	3.00	1.35	2.25	1.25	2.10	.90
Mine-run	2.50	1.10	2.25	1.10	2.00	.90
No. 1 nut	3.25	1.35	2.25–3.00	1.35	2.75	1.00
2-in. screen	2.50	.80	2.00	.85	1.85	.85
No. 5 washed	2.40	.70	2.00	.75	1.85	.70

Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run		Mine-Run
Pratt	$3.50	Carbon Hill	$3.25—3.50
Big Seam	2.75—3.00	Cahaba	3.75—4.00
Black Creek	3.75—4.00		

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ark., Batesville—The City Council has authorized an appropriation of $25,000 for improving electric-light and water-works system.

Calif., Los Angeles—The Llewellyn Iron Works, 1100-1218 North Main St., has had plans prepared for a 35 x 80-ft. power house.

Ga., Atlanta—The Georgia Ry. & Power Co., Electric and Gas Building, plans to sell $2,500,000 bonds and use the proceeds in building an additional generating unit in the Tallulah Falls power station and other improvements. Estimated cost, $330,000.

Fla., Leesburg—City plans to vote on $40,000 bond issue for lighting plant and water-works.

Ill., Bloomington—C. C. Williams, supt. of water and light, has prepared plans for improving plant involving two 500- and one 1000-kw.-ampere, two-phase, 60-cycle turbo-generator sets with all equipment, material for distributing line, a 3000-kw. transformer, 1500 cedar poles and 4000 Waltham meters. Estimated cost, $382,625.

Ill., Clinton—The Illinois Central R.R., 135 East 11th St., Chicago, has had plans prepared for a boiler and engine house. Estimated cost, $20,000. A. S. Baldwin, Chicago., Ch. Engr.

Md., Baltimore—The Goucher College, St. Paul St., plans to build a 1-story, 40 x 64-ft. brick and concrete power house on Oak St. Ellicott & Emmart, Union Trust Bldg., Engrs.

Mass., Boston—The Revere Rubber Co. plans to build a new 1-story, 20 x 60-ft. transformer house on Eastern Ave. for plant operation. Estimated cost, $10,000.

Mass., Pittsfield—The Barrett Co., 35 Wendell St., Boston, plans to build an addition to its local power plant.

Mo., Canton—City voted on a $10,000 bond issue for improving electric-light and water-works system.

Mo., Columbia—The McKinley Co. plans to build transmission lines to supply several towns in the northeastern section of the state.

Mont., Libby—The Great Northern Ry. plans to electrify road from main range of the Rocky Mountains westerly and will also build a hydro-electric plant at Kootenai Falls to generate the power required. A. C. Deverell, St. Paul, Minn., Supt.

Nev., Verdi—The Truckee River General Electric Co. of Reno plans to build a high-tension power line from Verdi to the Poeville mining district. E. D. Brown, Supt.

N. J., Flemington—The Lambertville Pub. Service Co., Lambertville, has acquired the Flemington electric-lighting plant and plans to extend its transmission lines and system.

N. Y., Buffalo—The International Ry. Co., Elliott Square Bldg., plans to build a new 1-story, 75 x 90-ft. electric substation on north Division St.

N. Y., Buffalo—The Pullman Co., Marine Bank Bldg., will build a 1-story, 60 x 110-ft. power house and electric building in connection with its new shops on Broadway.

N. C., Roxboro—The Little River Manufacturing Co. is planning to rebuild its power dam and improve its power system.

N. D., Kensal—The Kensal Electric Light and Power Co. plans to build an electric plant. Estimated cost, $6000.

Ohio, Cleveland—The Ohio Blower Co., 9301 Detroit Ave., plans to build a boiler house. Estimated cost, $20,000.

Okla., Miami—The Triangle Mines Co. recently incorporated with capital stock of $50,000, plans to build three mills with central power plant to operate same. N. C. Barry, pres.

Penn., Pennsburg—The Perkiomen Paper Co. will build a new 1-story boiler house addition to its plant.

Penn., Pittsburgh—The National Biscuit Co. is planning to build a power house on Penn Ave. and Lambert St. in connection with a new baking plant. Estimated cost, $25,000.

Penn., Temple—The Temple Malleable Iron and Steel Co. plans to build a 1-story, 65 x 81-ft. power house in connection with a foundry plant.

Tex., San Antonio—The San Antonio Traction Co. and the San Antonio Gas and Electric Co. has been incorporated with $4,700,000 capital stock, under the name of the San Antonio Public Service Co. The new company plans to extend its lines to Camp Kelly and other points and will build a large electric power plant. Address E. McDillon, New York City.

Tex., Terrill—Fred M. Lege, Jr., of Galveston, and associates, have purchased the electric light and power plant of the Terrell Electric Light Co., including a power transmission line from Terrell to Forney, and plan rebuilding and installing new machinery. H. L. Anderson, Engr.

W. Va., Raleigh—The Berkeley Woolen Mills, West Stephen St., is planning to build a new central power house for its plant on Raleigh St.

Wis., Milwaukee—The Sewerage Commission will soon receive bids for the building of a power house and necessary equipment. Estimated cost, $700,000 to $900,000. T. Chalkley, Halton, Engr. in charge.

Wis., Racine—The Wisconsin Gas and Electric Co. has increased its capital stock from $2,750,000 to $3,350,000 and plans to use proceeds in extending its electric plant and transmission system at Racine and through southern Wisconsin. D. E. Callender, Gen. Mgr.